HISTORY OF THE INVENTION

OF THE

ELECTRIC TELEGRAPH.

ABRIDGED FROM THE WORKS OF

LAWRENCE TURNBULL, M. D., AND EDWARD HIGHTON, C. E.

NEW YORK, 1853.

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LAWRENCE TURNBULL, M. D., AND EDWARD HIGHTON, C. E.,

WITH REMARKS ON

ROYAL E. HOUSE'S AMERICAN PRINTING TELEGRAPH,

AND THE CLAIMS OF

SAMUEL F. B. MORSE, AS AN INVENTOR.

New York:
WM. C. BRYANT & CO., PRINTERS, 41 NASSAU ST., CORNER LIBERTY.

1853.

HOUSE'S PRINTING TELEGRAPH.

Wm. C. Bryant & Co., Printers, 41 Nassau, cor. Liberty St.

HOUSE'S PRINTING TELEGRAPH.

"To converse and carry on intelligent discourse at the distance of many hundreds of miles, is not new; nay, it has become common; but to impress with the subtile electric spark through vast space, solid material, with the symbols of our language in the fulness of their proportionate beauty; to make the cold, dull, inanimate steel speak to us in our own tongue, surpasses the mythological narratives of ancient Greece and Rome, throws into the shade the fabulous myths of superstitious Arabia, and sinks into insignificance the time-honored traditions of the Oriental World."—*Dr. Turnbull on the Electric Telegraph, page* 96.

ELECTRIC TELEGRAPHS GENERALLY.

The three great fundamental principles on which all telegraphs at present in use depend are as follows:

The first is the discovery by Œrsted, viz.:

1. That a magnetic needle, when in proximity to a body through which a current of electricity is passing, has a tendency to place itself at right angles to such body, or, more strictly speaking, to rotate round that body.

The next is the discovery of the late Mr. Sturgeon, viz.:

2. That if currents of electricity pass around a bar of soft iron, the iron becomes temporarily-magnetic; and when in that magnetic condition it powerfully attracts to it any pieces of soft iron which may be placed in its vicinity.

The third is based upon the joint discovery of Sir Anthony Carlisle, Mr. Nicholson, and Sir Humphry Davy, viz.:

3. That when a current of electricity passes through certain chemical substances, those substances are thereby decomposed, or new compounds are formed.

On these three great fundamental principles all the telegraphs at present in use depend.

The Electric Telegraph itself may be fairly divided into three distinct and separate parts, viz.:

1. The means resorted to for producing electricity.

2. The means adopted for rendering a current of electricity cognizable to the senses.

3. The means usually employed for transmitting to a distant place the electricity required.

ON THE PRODUCTION OF ELECTRICITY.

Electricity may be produced in a variety of ways: by friction; by chemical action; by magnetic induction; by change of temperature; by the power and at the will of certain animals. The three first modes are those usually employed in the electric telegraph.

ON THE MEANS USUALLY EMPLOYED FOR TRANSMITTING ELECTRICITY TO A DISTANT PLACE.

It is evident how comparatively valueless for the purpose of telegraphing would have been the many wonderful discoveries in the production of electricity, if means were not to be found for conveying the power with little or no impediment or loss to a point remote from its source or origin.

This part of the subject for a long period occupied the attention of many of those engaged in the science.

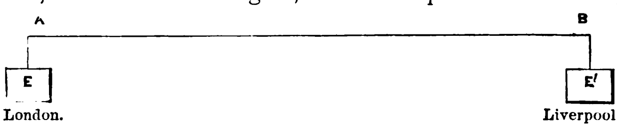
It was found, after many careful experiments, that several substances had the property of conveying electricity through them with but a very slight impediment to its passage. It has been known for upwards of a century that electricity could be transmitted over a very considerable distance by means of insulated wire, and that the effects produced in every part of the circuit were, if not absolutely instantaneous, yet practically so to all intents and purposes.

Dr. Watson, in 1747, stretched a wire across the Thames,

over Westminster Bridge. One of the extremities of this wire communicated with the exterior of a Leyden jar, and the other was held by a person in one of his hands, while the other hand grasped an iron rod. Another person on the opposite side of the river grasped a wire communicating with the interior of the jar. The moment the first-named person dipped the rod into the river, the current passed, and both persons received the shock. This appears to be the first time that a circuit composed partly of wire and partly of the earth was used for transmitting currents of electricity.

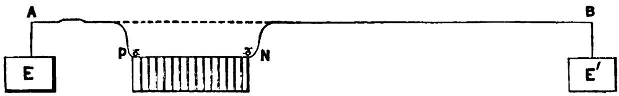
FIRST PRINCIPLES OF AN ELECTRIC TELEGRAPH.

Mr. Highton, in his work on the electric telegraph, gives the following popular explanation of the first principles of an electric telegraph. If a wire be made to extend between London and Liverpool, and be insulated from the earth all the way between those two points, and if the ENDS of such wire be made to dip into the earth both at London and at Liverpool, then such wire will form a proper channel for the transmission of an electric current from either London to Liverpool, or Liverpool to London. Suppose, therefore, in the annexed figure, that A B represents such wire,



and E E′ the respective earth connections at London and Liverpool; then if the wire be severed in two at A, and the two severed ends be joined respectively with the two poles of a galvanic battery, as shown in the following figure, a positive current will flow from P to E, and a negative current from N through B to the earth at E′, and it will return by the earth from E′ to E, so as to complete its circuit and affect the apparatus in such circuit.

Again, if the positive pole P be joined to the portion of wire extending to Liverpool, and the negative pole to the



London. Galvanic battery. Liverpool.

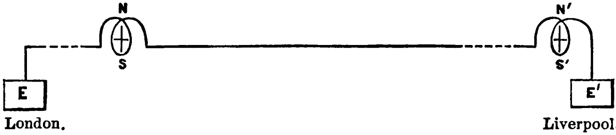
portion A at London, a positive current will pass to the earth at Liverpool and a negative one to the earth in London; and therefore opposite electrical effects will be produced on all instruments placed in the circuit of such wires.

Now, instead of turning the galvanic battery P N round, and thus connecting either the one pole or the other with the severed ends of the wire A B, it is evident that if the wire at such point of severance were joined to two keys in connection with the battery, and which keys were so arranged that the pressing of one down caused a positive current to progress to Liverpool and a negative one to London, and the pressing of the other down produced the contrary action, that by means of pressure upon either of two such keys either a positive or a negative current of electricity might be sent, as desired.

Again, if we suppose that when neither of such keys is pressed down, the ends of the severed wire at A (by very simple mechanical means) are allowed to *unite* metallically, the wire then becomes, electrically speaking, as it were unbroken or whole again. It might therefore, in the same manner, be severed at B, and the poles of another battery placed there might be attached to such severed ends at B, and by means of similar keys either a positive or negative current of electricity transmitted *from* Liverpool *to* London.

Such arrangement would enable a party at either London *or* Liverpool to cause currents of electricity to traverse the intervening wire, and similarly with respect to any number of intermediate stations placed in such circuit.

Now if at *both* London and Liverpool we put a coil of wire in the line circuit, as shown in the annexed figure, and make such coil surround a magnetic needle N S fixed on a moveable



axle, then when a current of positive electricity traverses the wire, the top of the needle will move in one direction, and when a negative current is sent it will move in the other direction. If, then, such coil or needle be placed *vertically*, the top of the needle will move to the right by the one current and to the left by the other current.

This being clearly understood, it is evident that if one movement to the *right* represent the letter *A*, two successive movements to the *right* might represent *B*, three movements *C*, and so on; and if one movement to the *left* represented *M*, two movements to the left might represent *N*, three movements *O*, and so on; and if one movement to the right, followed rapidly by one movement to the left, represented *S*, two of such movements might represent *T*; and that by *commencing* with a movement to the *left* and *following* it by a movement to the *right* another letter might be designated, and so on, with the various numbers of movements to the right or to the left; and with the combinations of one, two, three, or four of such movements in one direction with one or more movements in the other direction, all the letters of the alphabet could be designated.

Again, if instead of using a magnetic needle and coil, an electro-magnet had been employed with a moveable armature, on sending a current the armature of such electro-magnet would be attracted to the electro-magnet, and if a pricker or marker were affixed to such armature and a piece of paper

also were made to move near to such marker, every movement of the armature caused by the electric current would be recorded on the moving paper by the point pressing against or going through the paper; and if the current were continued for a long period, the *length* of the scratch or mark would be proportionally great. By a combination, therefore, of dots and long and short marks, all the letters of the alphabet might be designated in this way; or, instead of an electro-magnet being employed, the current of electricity might be made to decompose chemical substances on a piece of moving paper and change the color thereof. This would give the same means of enabling a person to read off the currents sent, and hence to understand the letters or signals intended to be transmitted. Similarly, also, with respect to all of the other enumerated means of testing the *presence* of an electric current transmitted through a conductor, *whether it be made to move a magnetic needle*, *to mark paper*, *to produce sparks*, to liberate mechanism, to remove screens, or to do any other pre-arranged work.

DESCRIPTION OF THE PRINCIPAL ELECTRIC TELEGRAPHS.

Let us now see how the above, as well as the many other plans of ascertaining the *presence* of an electric current in the *conducting wire*, have been employed by various parties for the purpose of telegraphic communication.

We will first mention some of the plans invented prior to 1837.

Lesarge, in 1774, employed at Geneva twenty-four wires and a pith ball electrometer.

Lomond, in 1787, employed in France one wire and a pith ball electrometer.

Betancourt, in 1787, used in Spain one wire and a battery of Leyden jars. He constructed an Electric Telegraph line from Aranjuez to Madrid, a distance of 26 miles.

Soemmering, in 1811, used galvanic electricity, and as many wires were employed as there were letters or signals to be denoted.

Schwieger, about the same time employed the principle of Soemmering's telegraph, but reduced the number of wires to two. He proposed methods of permanently registering the letters denoted—this was to be done by means of paper smeared with lampblack and other substances.

Ronalds, of Hammersmith, in 1816, erected eight miles of insulated wire. He proposed to the British Government an Electric Telegraph to be used along the coast in lieu of the Semaphore Telegraph. In 1823, he published a full description of his Telegraph, in a work entitled "Descriptions of an electrical telegraph and of some other electrical apparatus."

Ampere, in 1820, employed the magnetic needle, the coil of wire, and the galvanic battery.

Tribaoillet, in 1828, used but one wire; he employed a galvanic battery and a galvanoscope.

Dyer, in 1828, constructed a telegraph line on Long Island, New York; he strung wire on poles, used glass insulators and produced marks on chemically prepared paper by the electric spark.

Booth, in 1830, in Dublin, explained fully how electro-magnetism could be used to telegraph at a distance, and cause *marks to be made by the fall of the armature* from the horse-shoe magnet when the current was broken. We are not aware, however, whether this form of telegraphic apparatus can be called an Irish invention. The plan was, for the reasons hereafter stated, generally discarded by European Telegraphers, but was adopted by Mr. Samuel F. B. Morse in his caveat, filed 6th October, 1837.

Gauss and *Weber*, in 1833, constructed an electric tele-

graph at Göttingen, between the Observatory and the Cabinet de Physique (a distance of a mile and a quarter.) One wire and one needle only were needed. The power employed was magneto-electricity.

Prof. Wheatstone, in 1834, published a beautiful series of experiments on the velocity of electricity. This seems to have had an influence in directing his attention to the subject of the electric telegraph. During the month of June, 1836, in a course of lectures delivered at King's College, London, he repeated his experiments on the velocity of electricity with an insulated copper wire nearly four miles in length, and gave a sketch of the means by which he proposed converting his apparatus into an electrical telegraph, so that by the aid of a few finger stops, it was capable of conveying thirty simple signals, which, combined in various manners, were sufficient for the purposes of telegraphic communication.—*Mag. Pop. Sci.* 1836.

Steinheil had an electrical telegraph line, twelve miles long, in practical operation, in 1836, between Munich and Bogenhausen. The line had three stations in the circuit. This telegraph required only one wire and one or two magnetic needles as desired. The power used was magneto-electricity. The needles, as in former plans, were surrounded by coils of wire, and each could be made to move to the right or to the left by electricity generated from the magneto-electric machine. When it was desired to telegraph by sound, he made the needles strike against either of two bells. He had also a mode of permanently marking or recording the signs.

On 12th June, 1837, *Wheatstone* and *Cooke* obtained a patent in England for their needle telegraph, being the first patent for an electric telegraph obtained in that country. They used five wires. Their patent was for improvements on

former systems, and was confined to certain specified contrivances which were claimed to be novel. They afterwards introduced further improvements, by which they reduced the number of wires. Their first patent was sustained in 1851 by the English Court of Common Pleas at Westminster, in an action for infringement.

In 1837, an experiment was made on a line in England, through a circuit of thirty-miles in length. (Turnbull, p. 47.) The line of telegraph upon the Great Western Railroad in England was finished in July, 1839.—*Turnbull, p.* 60.

It is generally supposed in England that Wheatstone and Cooke invented the electric telegraph, because they were the first to bring the invention into public use in that country. But those gentlemen never encouraged the popular delusion in their favor, but only claimed certain mechanical improvements on the apparatus previously invented and used in different parts of Europe, and they did not make any claim to any of the scientific discoveries in electricity and magnetism above referred to.

On 6th October, 1837, Morse filed a caveat in the office at Washington for an electric telegraph apparatus. By this caveat he signified that he had not completed the invention. In a letter to the Secretary of the Treasury of the United States, dated September 27, 1837, he says that he had *not been able to test his plan until within a few weeks*, and that he had contracted with Mr. Alfred Vail to have a complete apparatus made to exhibit at Washington by the 1st Jan., 1838.

An experiment was made in the University of New York, over half a mile of wire, on the 2d October, 1837.

It does not appear when Steinheil and Wheatstone first completed their respective inventions. Of course the former

must have completed his a considerable time before he got the line above referred to in actual operation, and Wheatstone must have completed his some time before the issue of his patent. In the electric telegraph suits in this country, no evidence has been taken abroad.

The first patent granted in the United States for an electric telegraph was issued on the 10th day of June, 1840, to Wheatstone and Cooke for the needle or pointer telegraph. This patent was directed to take effect from the date of the English patent, 12th June, 1837.

The second patent was granted to Mr. Morse for an "improvement" in the mode of communicating information by signals.*

This patent was issued on the 20th day of June, 1840. He first began to build a line in 1843, from Washington to Baltimore, and it was finished in June, 1844. Congress granted an appropriation to pay the expense, as it was found that commercial men did not believe that Electric Telegraph lines would yield a profit. The same doubts as to the commercial success of the Telegraph, prevented the extension of lines generally in Europe for commercial purposes.

Morse used the galvanic battery, and an electro-magnet of iron at the receiving station. The armature of this electro-magnet was to have attached to it a pen with ink in, or a pencil, for the purpose of marking paper, which was to pass uniformly along in front of the pen. The pencil or pen was afterwards abandoned for the use of a steel pricker.

The first symbols used were characters like a V; afterwards, when the pricker was used, it made small holes in the paper, or formed long scratches on it, accordingly as the current of

* In August and September, 1837, Mr. Morse, in letters, &c., claimed to have been the first who had conceived the idea of an electric telegraph of any description. The public generally supposed, and still believe, this claim to be correct.

electricity was kept on for a short or long period. The combination of dots and long strokes thus formed his alphabet. A dot followed by a dash stood for A, a dash followed by three dots for B, two dots followed by a small space and then another dot for C, a dot followed by a space and then two dots for R, three dots at exact distances from each other for S, and so forth.

Morse's patent refers to the needle Telegraph as a previous invention, also to the fact that different modes of transmitting intelligible signs had been used by means of the passage of a current of electricity through certain chemical compounds. He obtained a patent himself for one of these modes in 1849. He claimed that his was the first marking Telegraph, but many of the old chemical Telegraphs had been marking ones. Various other modes of marking had been invented and made public, and it has been seen that Steinheil completed his apparatus, and had it in actual operation upon a line, even before Morse filed his caveat, preparatory to an application for a patent, and six years before Morse had his apparatus in operation upon a line.

There is a considerable difference of opinion on the question, whether Morse's plan of marking has any advantages over the needle or pointer Telegraph, in which the needle is made to point to plain letters. Telegraphers in London and Paris seem to concur in the opinion, that on the whole it has not a balance of advantages; and upon some of the lines in this country, where the right to use Morse's system of recording has been purchased, the recording apparatus has been discarded, and messages have been transmitted by sound.

When the signs of letters are marked correctly on paper, they can be translated at any time afterwards, but the operator with any of the telegraphs which mark signs of letters by the processes above mentioned, must not only be careful

to count the proper number of dots, or dots and dashes, or dashes, as may be required to be made for each letter, but must also have a very delicate appreciation of time, for if he keep his finger on the finger key the tenth-part of a second too long, he makes a dash where there should be a dot, and on the other hand, if he remove his finger too quickly, he has a dot instead of a dash, so the slightest miscalculation of time will cause the wrong spaces to be left between the dots and produce great confusion. Moreover, the operator must keep up a regular motion of the finger key, corresponding with the speed of the paper moved at the other end of the line by clockwork. Of course, in translating the signs thus made, reliance has very frequently to be placed on the supposed sense and meaning of the passage. The transmission by sound, and by the pointer Telegraph, is, for these reasons, deemed to have a balance of advantages, and it is, therefore, most probable that those chemical and electro-magnetic Telegraphs which record dots and dashes in the manner above described, will be superseded by the pointer Telegraph, and the printing Telegraph. The former is especially available on lines of secondary importance, on account of its simplicity, and because a very slight current suffices to deflect a magnetic needle, which is an important consideration on cheaply built lines in bad weather, when a great part of the current escapes. Besides, in working the needle telegraph there is not much liability to error, as there is a considerable number of signals so distinct that they are not at all likely to be confounded with each other, and no minute observance of time is required. It is the practice with Companies using this form of Telegraph in England, to insure the accuracy of messages sent over their lines. As to the dispatch under this system, it is quite equal to that of any of the *signal marking* telegraphs.

In England the instrument generally used is the double

Needle Telegraph. The letters are denoted by counting the number of movements of the needles, to the right or left, a principle which was adopted by many inventors of Telegraphs before any patent was taken out.

The Telegraphs used in France are, for the most part, of the class known as revolving pointer Telegraphs. For railway purposes one wire only is used. In this case the pointer, as it revolves, stops successively at the letters on the circular dial which are intended to be denoted.

In the Government and Commercial Telegraphs two wires are used, each wire having its own revolving indicator connected with a separate maintaining power.

Each of these two indicators can be made to rest in any one of eight different positions in the circle.

It is evident, therefore, that 8 x 8 or 64 *primary* signals can be transmitted by this form of Telegraph.

In Prussia and Germany, on a few lines, a modification of Morse's apparatus has been used, with a new set of signs, but the kind of telegraphic instrument at present most usually employed is of the class known as the revolving pointer, or step-by-step movement telegraph. In this form of telegraph, as the hand revolves, it can by mechanism be made to rest, and thereby point out successively the letters on a circular dial. The instruments used are those of Siemens and Fardly. (Highton, p. 149.)

In 1848, Mr. Royal E. House, a native of Vermont, obtained a patent for the *Letter-Printing* telegraph, to date from April 18, 1846. Observing the repeated manipulations necessary to produce a sign of a letter under the existing systems, and the great liability to error in the transmission and translation of mere signals, he devoted himself to the invention of apparatus which would avoid these objections. By his plan, one manipulation suffices to produce a plain

letter, instead of several manipulations being used to produce a mere sign of a letter, which has to be translated. A great saving of time is effected and mistakes are avoided. To attain this brilliant result, Mr. House devoted himself with untiring energy for six years. On 28th Dec., 1852, he obtained a patent for various improvements on the original machine, and the ordinary speed of telegraphing newspaper reports by the improved instrument is at the rate of 160 letters per minute.* Mr. Jacob Brett, as assignee of Mr. House, obtained a patent in England for the original machine. The patent was granted as for an imported invention. The improvements patented here in 1852 have not yet been introduced in England, and Brett's machine is comparatively very slow.

The following explanation of the machine will give a popular idea of its mode of operation:

The different letters are signalized from one station to another by the transmission of a number of electrical impulses for each letter, by the rapid opening and closing of the electric circuit. At each station there is a key-board, (similar to the key-board of a piano-forte,) upon which there are twenty-six keys, each having a letter of the alphabet marked upon it, and one key marked with a dot and one left blank.

Under the key-board is a horizontal cylinder which is kept revolving by the turning of a crank and fly-wheel. At one end of this cylinder is a cog-wheel, with fourteen cogs, and consequently fourteen spaces between the cogs. This wheel is called the circuit wheel, being connected with the electric circuit by a spring which presses upon a cog or passes over

* Business messages are sent at the rate of from 200 to 250 letters per minute; 365 letters have been printed in one minute from New York to Utica.

a space as the wheel revolves. When this spring is upon a cog the telegraphic circuit is closed; when it is in a space the circuit is broken.

Upon the underside of each key there is a pin fixed directly over a similar projection on the cylinder. By the revolution of the circuit-wheel the circuit is rapidly broken and closed until a key is depressed, when its pin comes in contact with one on the cylinder, and the motion of the latter and of the circuit-wheel is arrested; when the key is released the cylinder and wheel again revolve until another key is depressed, and the circuit is opened and closed as many times as there are spaces from the last key to the next one which is depressed. Each opening and closing of the circuit is communicated through the line wire to an axial magnet at each station, which is thus caused to vibrate an equal number of times; each vibration of the magnet changes the direction of a current of compressed air to opposite ends of a small cylinder in which a piston moves backwards and forwards, which piston is connected by an escapement (somewhat similar to that of a watch,) with a wheel having the letters of the alphabet engraved upon its edge corresponding to the letters on the keys. The result is, that this type-wheel is thus made to advance as many letters as there are vibrations of the magnet and movements of the piston, corresponding to the number of times the electric circuit is broken and closed between the depression of one letter key and another.

It only requires that the instruments at both ends of the line should be set to the same letter, and then the cylinder at one extremity, and the type-wheel at the other, regulated by the pulsations of the electric current, in combination with the compressed air, will always revolve at the same rate; and if the cylinder is stopped at any one point representing a letter the type-wheel is stopped at the same point, and presents the

corresponding letter on its periphery to the strip of paper placed in front of it. When the type-wheel stops, an eccentric, moved by the manual power at the crank, draws the inking band and paper forcibly against the type, and a letter is thus impressed on the paper. The paper is then carried on by the machinery the distance of a letter, and is ready for another impression.

The action of the electricity and compressed air in this telegraph is merely to produce correspondence of motion between the machines at different points of the line, so that the particular letter desired, and no other, may be printed. All the mechanical results are produced by the manual power.

The axial magnet moves only about the sixtieth part of an inch each vibration, and from sixty to eighty times in a second. A slight current of electricity is sufficient to produce this effect, as the magnet combines attraction and repulsion, and thereby a great advantage is secured in the acquisition of power, so much so that messages are sent over long distances by House's Printing Telegraph, without the aid of local or branch circuits which are necessary for other systems of telegraph. As observed by Judge Woodbury, from the bench, this machine "literally gives letters to lightning as well as lightning to letters."

The operator sends messages as fast as he can touch the keys in succession using both hands, and every time he touches a key, a plain letter is printed. He can keep his eye upon the manuscript just as a performer upon a piano forte keeps his eye upon the music notes, and not upon the keys.

If, owing to any temporary disarrangement, the letter touched on the key board is not printed at the place of destination, no other letter is printed which can deceive the operator at the receiving station; but letters fly off rapidly in con-

fused order, and a signal is given at once to the operator at the transmitting station to adjust his instrument, which is effected in a moment.

The advantages of this system are despatch, accuracy and economy. The machines cost more in the first instance than the apparatus for the dotting and signal telegraphs, but the expense, trouble and errors of translating and copying the messages are avoided. The operator merely touches a lettered key once, and the machinery with unerring accuracy produces a similar letter, whilst by other systems a number of manipulations, say on the average three for each *sign* of a letter, are required. It is evident that even with the needle telegraph, there is a vast deal more danger of making mistakes in *transmitting* messages than there is in the use of the House Printing Telegraph, to say nothing of mistakes in *translating* the signs and in writing out the message.

To perfect the electric telegraph, it was necessary to make machinery to supersede the doubtful action of human fingers.* Mr. House undertook to do so, and after years of toil he succeeded beyond his most sanguine expectations. The importance of the result is appreciated by those who are practically acquainted with the use of the instrument, and by the public at large. Messages have been sent by this system from Washington to Utica, by way of New York, without being repeated—a distance of 600 miles. Congressional reports are sent through from Washington to New York without being repeated, a copy being dropped at Baltimore and Philadelphia, the distance by telegraph being 280 miles.

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* This is apparent from the fact that a short time since a great many messages sent over from New York to Cincinnati, were examined with the manuscripts, and it was discovered that there was at least one mistake in four messages out of five.

House lines now run from New York to Philadelphia, Washington, Boston and Buffalo, and from Buffalo to Cincinnati and Louisville; and other lines are projected in various parts of the country.

Dr. Turnbull observes that "This instrument has been appropriately termed one of the wonders of the age," and that it "will add a new laurel to the brow of the American people." He adds, that "for beauty of design and utility it will strike at once even those uninitiated in the mysteries of electric telegraphing, by placing in their hands communications from their friends, thousands of miles off, in the course of a few minutes; a message, printed in Roman letters, which requires no translation. This wonderful piece of mechanism is worthy of the study of those interested in the physical sciences, as it combines principles of mechanics as well as the reciprocal action of electric and magnetic currents."

A small signal telegraph machine has been recently constructed which is intended mainly for railroad purposes. It is very simple, is worked with keys in the same manner as the printing instrument, and can be operated by the persons in the employ of railroad companies, special operators not being required. It can be put up in passenger trains and attached to the telegraph line, when the conductor can warn approaching trains in case of accident, and send for special engines, &c.

The House Printing Telegraph is now on exhibition at the Crystal Palace, N. Y., with a competent operator to minutely explain all its parts, and show its practical working.

HISTORY OF THE PROGRESS

OF THE

ELECTRIC TELEGRAPH.

HISTORY OF THE PROGRESS

OF THE

ELECTRIC TELEGRAPH:

COMPILED CHIEFLY FROM

Lectures on the Electro-Magnetic Telegraph, with an Historical Account of its Rise and Progress. By Lawrence Turnbull, M.D., Lecturer on Technical Chemistry at the Franklin Institute, of the State of Pennsylvania. 1 vol., 8vo, pp. 186. Illustrated with Engravings.—Phil.: 1852.

The History of the Electric Telegraph, as detailed in the opinion of Judge Woodbury, of the Supreme Court of the United States.

The Electric Telegraph, its History and Progress, with numerous Illustrations. By Edward Highton, C.E. London: John Weale, 59 High Holborn, 1852.

The following extracts and remarks will serve to corroborate the foregoing statements, and will furnish various details which, in many instances are amusing and highly instructive.

Dr. Turnbull's Lectures are published from the Journal of the Franklin Institute, and the substance was delivered in a course of lectures before the Institute during the session of 1850 and 1851.

Dr. Turnbull traces the history of the various kinds of Electric Telegraphs from the earliest published suggestions and experiments. The peculiar properties of electricity, upon which the action of the Telegraph depends, are its passage along conducting bodies—the power to render iron a temporary magnet—its capability to decompose chemical combinations, and cause deflection of the galvanometer needle.

As early as the year 1729, *Mr. Grey* and *Mr. Wheeler* observed the instantaneous discharge of electricity through some hundreds of feet of wire.

In July, 1747, *Dr. Watson*, Bishop of Llandaff, together with several other electricians, ascertained the passage of electricity through water, by sending shocks across the Thames; experiments which they subsequently repeated on a still larger scale through the New River, at Newington; and in August, 1747, they transmitted shocks through two miles of wire, and two miles of earth at Shooter's Hill. The passage of electricity through water excited a great deal of interest, and these experiments were repeated in 1748, by Franklin, across the Schuylkill, at Philadelphia; and in 1749, by DeLuc, across the Lake of Geneva.—(Turnbull. p. 4.)

" Though electricity is the agent used in common by all telegraph operators, its modes of application have been as manifold as the number of laborers in this most interesting combination of science and art. Those now in use, and before described by historians, can be included in three divisions:—Taking them in the order of discovery and application, we have, first, the electric, in which simple frictional electricity was alone used; next, the galvanic, where voltaic electricity was employed; and last, the electro-magnetic—combining the agencies of electricity and magnetism. The first was used during the period from 1745 to 1800; the second from 1800 to 1825; the third from 1825 to the present time, From 1820 to 1850, there have been no less than sixty-three claimants for different varieties of telegraph."

LESAGE'S TELEGRAPH.

" The first real attempt which seems to have been made to render electricity available for the transmission of signals is

described by Moigno, in his *Traité de Telegraphie Electrique.* It is that of Lesage, a scientific Frenchman, who in 1774 established an electric telegraph at Geneva, composed of twenty-four metallic wires, separated from each other, and immersed in a non-conducting matter. Every wire corresponded with a particular electrometer, formed of a small ball of elder, suspended by a wire. By placing an electrical machine in communication with either of these wires, the ball of the electrometer which corresponded to it was repulsed, and the movement designated the letter of the alphabet, or whatever conventional signal it was wished to transmit." (Turnbull, p. 4).

LOMOND'S TELEGRAPH.

In the first volume, page 42, of Arthur Young's *Travels in France*, during the year 1757, will be found the following:

"Mr. Lomond has made a remarkable discovery in electricity. You write two or three words upon paper; he takes them with him into a chamber, and turns a machine in a cylinder case, on the top of which is an electrometer, having a pretty little ball of pith of a quill suspended by a silk thread; a brass wire connects it to a similar cylinder and electrometer in a distant apartment, and his wife, on observing the movements of the corresponding ball, wrote the words which it indicated. From this it appears that he had made an alphabet of movements; and as the length of the brass wire made no difference, you could correspond at a great distance, as for example, with a besieged city, or for purposes of more importance."

Electricity was generated and retained by the common machine and a Leyden phial. Having but one movement, and using an apparatus extremely delicate, we must suppose this mode of communication to be limited and dilatory."

REUSSER'S TELEGRAPH.

In *Voight's Magazine* for 1794, vol. 9, p. 183, there is a letter from Reusser, of Geneva, in which he describes an electric telegraph. Signals were transmitted by sending electric shocks through the different wires, and noting down the letters attached to strips of tinfoil where the sparks were observed. The attention of the observer, at a distant station, was drawn by firing an inflammable air pistol, attached to the apparatus, by means of an electric spark.

BOECKMAN'S TELEGRAPH.

A similar and yet more practical proposition was soon after made by Professor Boeckman. He proposed to choose as the signals the sparks passing at the distant station, using *only two wires*, by which, first one, and then after certain intervals more sparks being *combinedly grouped*, indicated the particular letter—(Turnbull, p. 5).

SALVA'S AND BETANCOURT'S TELEGRAPHS.

"The *Madrid Gazette*, of November 25th, 1796, states that the Prince de la Paix, having heard that M. D. F. Salva had read to the Academy of Sciences a memoir upon the application of electricity to telegraphing, and presented at the same time an electric telegraph of his own invention, desired to examine it; when, being delighted with the promptness and facility with which it worked, he presented it before the king and court, operating it himself. After these experiments, the Infanta Don Antonio desired another more complete telegraph, and occupied himself in testing the quantity of electricity that would be required by the telegraph at different distances, whether on land or water.

"Some useful trials were made and published in *Voight's*

Magazine. Two years after, the Infanta Don Antonio constructed a telegraph of great extent on a large scale, by which the young prince was informed at night of news in which he was much interested. He also invited and entertained Salva at court. According to Humboldt, a telegraph of this description was established in 1798 from Madrid to Aranjuez, a distance of 26 miles. Other writers affirm that M. Betancourt established a line of telegraph between the same places in 1787, and worked it with frictional electricity."

RONALDS' TELEGRAPH.

In 1816, Mr. Francis Ronalds, of London, constructed an electric telegraph, by means of which he was enabled to send signals with considerable facility and rapidity through a distance of eight miles, using frictional electricity. He published a work in 1823, describing his Telegraph, and illustrating it with plates; also several electrical instruments of his invention —(Turnbull. p. 6)—and he proposed to the English government to establish an electric telegraph round the coast of England.

DYER'S TELEGRAPH.

In 1827–8, Harrison Grey Dyer, an American, constructed a telegraph at the race-course on Long Island, and supported his wires by glass insulators fixed on trees and poles. By means of common electricity acting upon litmus paper, he produced a red mark, and then passed the current through the ground as a return circuit—(Turnbull, p. 6).

Dr. Turnbull observes (p. 7), that Dyer's instrument was far inferior to that of Sœmmering, invented twenty years before, and indicated a want of proper regard for or information of the discoveries of Galvani, Oerstead, Ampere, and a host of others. Besides, frictional electricity was used by Dyer, and that is too easily dissipated.

Galvanism.—Dr. Turnbull, after showing the various kinds of electric telegraphs where frictional electricity was used, explains how galvanism was discovered by *Galvani*, Professor of Anatomy at Bologna, and the voltaic pile by Professor Volta, of Pavia. Common or frictional electricity had been found inefficient for telegraphic purposes, being too easily dissipated, rapid and incontinuous in action, confined with great difficulty to conductors, and devoid of that dense, energetic, yet almost imperceptible force which renders galvanic electricity so available in this art.

"The invention of the pile by *Volta* was the result of profound thought on the development of electricity at the surface of contact of different metals.

"The galvanic pile of Volta consisted of an equal number of silver coins and pieces of zinc of the same form, with circular discs of card soaked in salt water; of these he formed a pile or column, by placing them alternately. If the uppermost disc of metal, either copper or silver, be touched with the finger, previously wetted, while a finger of the other hand is applied to the lowest disc, a distinct shock is felt, which is increased with the number of plates. Instead of the moist conductor, we now use liquids of various kinds; and electricians have devised various forms of batteries, but all based upon the important principle discovered by Volta."—(Turnbull, p. 8).

Professor *Daniell* was the first to invent a battery capable of constant and steady action. Another form of battery, proposed by Professor *Grove*, of London, is an improvement on Professor Daniell's, and has been adopted in most of the telegraph offices of this country—(Turnbull, p. 9).

SÖMMERING'S TELEGRAPH.

Sömmering, of Munich, first applied galvanism to telegraphing. In 1809, he constructed an apparatus which, by decom-

posing water, enabled him to give signals. His mode of doing so is fully explained by Turnbull, and the various contrivances invented at different times are illustrated by wood-cuts or copperplate engravings. The work is the fullest and most complete on the subject yet published in this country.

Professor Steinheil, in 1837, employed the earth as a return portion of the circuit between telegraphic stations, and nearly all the telegraph lines are arranged on this principle. Much speculation has arisen as to the mode in which the electrical impulse is conveyed through the earth between the termini: though it is as much under our control as when transmitted through wire conductors, it is difficult to conceive the passage of the fluid in these cases as similar.—(Turnbull, p. 14.)

The Electro-Magnet.—" *Mr. William Sturgeon*, a native of London, about the year 1825, discovered that when wires of soft iron were placed within the coil of a conducting wire, they were rendered intensely magnetic.

" Our knowledge of this subject was afterwards greatly extended during the period from 1828 to 1831, by the researches of *Professor Henry*, Secretary of the Smithsonian Institute at Washington"—(Turnbull, p. 29).

Electro-magnetic Telegraphs are the result of *Oersted's* discovery that feeble electric currents would produce a variety of magnetic actions.

Ampère's Plan.—Numerous forms of telegraphic apparatus were proposed. In 1820, Ampère suggested the employment of the deflexion of the magnetic needle by the agency of the galvanic fluid. " His plan was to have as many magnetic needles as there are letters of the alphabet, which might be put in action by the passage of currents through metallic

conductors made to communicate successively with the battery by means of keys which could be pressed down at pleasure, and might give place to a telegraphic correspondence that would surmount all distance."—*Ann de Chem. et de Phys. XV.* 73.

Barlow's Plan.—In 1828, *Peter Barlow*, F.R.S., suggested the establishment of a telegraph by means of conducting wires and compasses.—*Edinburgh Philosophical Journal*, Vol. 12, p. 105.

ST. AMAND'S TELEGRAPH.

In 1828, *St. Amand* proposed to establish a telegraphic line from Paris to Brussels. He devised a mode of insulating the wire, and proposed by means of a powerful galvanic battery to transmit the current to a distant point "to an electroscope destined to render sensible the slightest influence; and he left to each one to adopt, at pleasure, the number of motions to express the words or letters which they might need."—*Report of Academy of Industry, Paris, from Vail's E. M. Telegraph*, p. 138.

SCHELLING'S TELEGRAPH.

In 1832 and '3, *Baron Schelling*, a Russian Counsellor of State, occupied himself with an electro-magnetic telegraph, operating by the deflection of a number of needles.—*Turnbull*, p. 38.

GAUSS AND WEBER'S TELEGRAPH.

Gauss and *Weber*, two illustrious German philosophers, established, in the year 1833, telegraph communication between the Astronomical Observatony, Physical Cabinet, and Magnetic Observatory at Göttingen. It consisted of a double

line of wires carried over the houses and steeples at Göttingen. The circuit employed in 1833, was about eight thousand feet, and in 1834 or 1835, at least fifteen thousand, but part of this wire was reeled. Notices of this telegraph were published in 1834. "They first employed galvanic electricity by employing small sized plates, and found that the action was much increased by adding to their number. They repeated and perfected their first form of telegraph by applying the phenomenon of magnetic induction discovered by Prof. Faraday. The diverse movements of the slow oscillations of magnetic bars caused by the passage of the currents, and observed by the aid of a glass, furnished to Gauss and Weber all the signals which they wished in corresponding, but the number of signals which could be transmitted was few, and the time occupied by each considerable. The main apparatus was a magnetic-electric machine, and to this Counsellor Gauss adapted a peculiar arrangement, by which the direction of the current can be reversed by a single pressure of the finger."—(Turnbull, p. 39.)

STEINHEIL'S TELEGRAPH.

The first notice we find of Steinheil's Electro-magnetic Telegraph is in a communication from Munich, dated December 23, 1836, published in the 3d vol. of the Magazine of Popular Science: "Professor Steinheil has fitted up a Telegraph here according to the plan of Prof. Gauss, and similar in principle to that which connects the Observatory and Cabinet of Natural Philosophy at Göttingen." According to the authority of Mr. Morse, Steinheil's telegraph was adopted by the Bavarian Government, and was in actual operation during his visit to Europe in 1838. According to the same authority, in 1838, "Prof. Steinheil's telegraph

was the only European telegraph that proposed to write the intelligence."—*Turnbull*, p. 70.

The following is an extract from an article by Steinheil, published in the *London Annals of Electricity*, March and April, 1839:

"To Gauss and Weber is due the merit of having, in 1833, actually constructed the first simplified galvano-magnectic telegraph.

"It was Gauss who first employed the excitement of induction, and who demonstrated that the appropriate combination of a limited number of signs is all that is required for the transmission of communications.

"Weber's discovery that a copper wire 7460 feet long, which he had led across the houses and steeples at Göttingen from the Observatory to the Cabinet of Natural Philosophy, required no special insulation, was one of great importance. The principle was thereby at once established of bringing the galvanic telegraph to the most convenient form. All that was required was an appropriate method of inducing or exciting the current, with the power of changing its direction without having recourse to any special contrivances for that purpose. In accordance with the principles we have laid down, all that was required in addition to this was to render the signals audible; a task that apparently presented no very particular difficulty, inasmuch as in the very scheme itself *a mechanical motion*, namely a deflection of a magnetic bar, was given. All that we had to do, therefore, was to contrive *that this motion* should be made available *for striking bells or making indelible dots. This falls within the province of mechanics, and there are, therefore, more ways than one of solving the problem.*"

Steinheil goes on to describe his marking telegraph, which was somewhat similar to Morse's, as it made indelible dots which were the representatives of letters. Steinheil calls this

"an *alteration* in the telegraph of Gauss" before referred to, where the oscillations of the magnetic bars were the subject of ocular inspection. But Steinheil adds, "I by no means, however, look on the arrangement I have selected as complete, but as it answers the purpose I had in view, it may be well to abide by it till some simpler arrangement is contrived." (*See Highton's description of Steinheil's telegraph, post.*)

A mechanical motion having been once obtained at a distant point, by means of electric currents, of course mechanics could easily devise a great many ways of making evanescent signs or sounds, or marking indelible dots and scratches. It was not so easy, however, to make use of the motion so as to print plain letters, as that required extraordinary mechanical skill, and various ingenious additional appliances.

Dr. Turnbull (p. 70) says, "Steinheil's alphabet is one of great beauty and simplicity, displaying the man of learning and refinement; as, for example, his musical bells, producing sounds which, striking upon a cultivated ear, conveyed a telegraphic language in imitation of the human voice. But he did not confine himself to the production of evanescent sounds, he also employed the simple dot, so as to fix them permanently upon paper, that they could be recalled again. This form of telegraph is a combination of the successive fundamental discoveries of Professors Oersted and Faraday, with the multiplication of Schwieger."

COOKE AND WHEATSTONE'S TELEGRAPH.

In 1837, Professor Wheatstone, of King's College, London, matured the invention of the Telegraph known as Wheatstone and Cooke's Needle Telegraph, a patent for which was issued in England on 12th Dec., 1837, it having been sealed the 12th June previous.

"The principle on which this Telegraph depended, was that of combining several peculiarly constructed galvanometer needles. It was an application of Oersted's discovery of the deflecting influence of an electric-current upon a magnetic needle."—*Turnbull*, p. 58. (*See Highton's description of Cooke and Wheatstone's telegraph, post.*)

Wheatstone and Cooke took out a patent at Washington for this invention, on 10th June, 1840, to run from the 12th of June, 1837, that being the date of the English patent.

The English patent has expired, and a renewal was refused by the Judicial Committee of the Privy Council, on the ground that the patentees had been sufficiently remunerated. The patentees, whilst their patent was in existence, maintained suits successfully against parties who used any of their improvements in the mode of transmitting intelligence by means of electric currents. One of these suits was tried in the year 1851, and the decision of the Court at Westminster is reported in Dr. Turnbull's book, p. 67. Wheatstone and Cooke only claimed certain specified "improvements in giving signals and sounding alarms in distant places by means of electric currents transmitted through metallic circuits." It is understood that they never made any thing out of their patent in the United States; the system patented by Mr. Morse being considered an improvement on the Needle Telegraph, and being supported by a grant from Congress of a sum of money sufficient to build an experimental line from Washington to Baltimore. This line, however, was not commenced until March, 1843. It was completed in June, 1844. Lines had been built before this in England. In 1837, an experiment was made on a Railroad, through a circuit of thirty miles in length. (Turnbull, p. 47.) The line of telegraph upon the Great Western Railroad was finished in July, 1839. Thirty signals were made in a minute. (Turnbull, p. 60)

Professor Wheatstone took out new patents in 1838 and 1840, for further improvements. Professor Morse endeavored to take out a patent in England for his apparatus for marking signs, but his application was refused on the ground that the invention had been published previously in England, in the Mechanic's Magazine. He had better success in France, there being no obstacles in the way of applicants for patents in that country, but the French patent afforded him no profit, as the invention has not been adopted.

MORSE'S TELEGRAPH.

As far back as 1832, Mr. Morse had his attention directed to electric telegraphs, and it has been made a subject of controversy between him and Dr. Jackson, of Boston, as to which of them first suggested to the other, in the year 1832, the idea that intelligible marks or signs might be made by means of electric currents. But neither of these gentlemen knew much about the subject at the period above referred to—not being aware that there had been electric telegraphs in any part of the world.

It appears that Dr. Jackson and Professor Morse met, for the first time, as fellow passengers, homeward bound, on board the packet ship Sully, in 1832. Morse was a painter. Jackson had cultivated the sciences. Morse was but little acquainted with electricity and electro-magnetism. Jackson was fresh from the lectures of Pouillet on electro-magnetism at the Sorbonne; and had in his possession an excellent electro-magnet, and two small galvanic batteries for putting it in action. Morse admits that his first idea of a telegraph was conceived during a conversation among the passengers on the recent discoveries in electro-magnetism, and was suggested by observations of Jackson upon the length of wire in the coil of the magnet, and the instantaneous transmissibility of the

electric current through its entire extent. According to Jackson he mentioned to Morse and some of the other passengers various modes by which intelligence might be transmitted to a distance by means of electrical action.

1st. To count the sparks in the disjoined wire circuit, and to note the number successively given, per watch, so as to denote the numbers.

2nd. To perforate paper by the sparks from the Leyden jars and common electric machine.

3rd. To decompose certain saline or metallic salts, by means of a galvanic current communicating with platina points, connected with conducting wires of copper and the galvanic battery.

4th. By the lifting power of the electro-magnet to move a lever beam, and make marks.

Morse on the other hand asserts that Jackson only spoke of chemical telegraphs, but that he himself, while on board the Sully, conceived the idea of using the apparatus afterwards adopted by him; and he called upon the Captain of the packet ship, to prove that he saw in 1837, at the University in New York, the identical thing which Morse had planned and described on board the Sully.

Although Morse at the time of the conversation on board the Sully may have known but little about electricity and electro-magnetism beyond what Jackson told him, and although Morse does not claim to have had any extraordinary mechanical talent, yet there is nothing surprising in his statement, corroborated by Captain Pell, that he conceived the idea at once of using the electro-magnet in the way suggested; nor is it astonishing that Dr. Jackson should mention various ways of marking the presence of electricity at a distant point. Morse at that time seems to have busied himself chiefly in inventing a system of signs, but he might have found several

on consulting the Encyclopædias. Alphabets of dots and lines are among the methods of writing in cipher, described in Rees' Encyclopædia.

As observed by Professor Joseph Henry: "the idea of transmitting intelligence to a distance, by means of electrical action, has been suggested by various persons, from the time of Franklin* to the present: but until within the last few years, or since the principal discoveries in electro-magnetism, all attempts to reduce it to practice, were necessarily unsuccessful. *The mere suggestion, however, of a scheme of this kind*, is a matter for which little credit can be claimed, since it is *one which would naturally arise in the mind of almost every person, familiar with the phenomena of electricity.*"

Plans of electric telegraphs had been common before the year 1832, and a great many had been published, but certain scientific discoveries and improvements in the mode of generating and conducting electric currents were necessary before the practical establishment of telegraphs could be effected. Morse had nothing to do with these discoveries and improvements, and the fact that in 1832 he thought of one or more of the various forms of an electric telegraph does not place him in advance of others. Such ideas were commonly entertained at that time and previously, and many others had not only thought of these matters, but had so far perfected different plans as to describe them fully and publicly, and had constructed their apparatus. Morse cannot be put in the front rank with them in the year 1832, on the strength of the commonplace remarks made by him at that time. He

* Others preceded Franklin in experiments on the instantaneous transmissibility of electric currents along conductors. See ante p. 24.

kept silent for many years afterwards, and at last on October 3rd, 1837, made out a caveat describing a "rude apparatus" and stating that he had not yet completed his invention sufficiently to enable him to apply for a patent. We cannot go back to 1832 as the date of the invention of Morse's apparatus. If Morse had read or heard of the electric telegraph, as he might have done forty or fifty years before, had he been alive, he might with equal propriety have gone back to that date.

Nor must it be supposed that the idea of using the motive power of the electro-magnet to make marks with, was essential to the practical success of the electric telegraph or to the marking or recording of signs. On the contrary the direct action of the electric current without an electro-magnet has many advantages, and the pointer telegraphs are generally deemed to have a balance of advantages over all kinds of marking telegraphs by which mere signs of letters are produced by the breaking and closing of the circuit with a finger-key or similar contrivance.

Morse devoted but very little attention to the subject of the electric telegraph until the year 1837. He says that up to the autumn of that year, his telegraphic apparatus existed in so rude a form, that he felt a reluctance to have it seen, and that in the latter part of August or beginning of September, 1837, the instrument was shown in the cabinet of the University (N. Y.) to numerous visitors, operating through a circuit of 1700 feet of wire running back and forth in that room.

On 6th October, 1837, Morse filed a caveat, dated the 3rd of the same month. The law required the caveat to set forth the "principal and distinguishing characteristics" of the invention. It provides that any one who has invented a new machine, &c., "and shall desire *further time to mature the same,*"

may file in the Patent Office a caveat setting forth the principal and distinguishing characteristics of the invention and praying protection of his right *till he shall have matured* his invention.

The caveat declared that "the following is a full and exact description of said telegraph, so far as it is at present completed."

The caveat speaks of conductors through which the current is to be passed, "by means of any generator of electricity," and proposes a system of signs—a contrivance which he calls the type and port rule with which he intended to break and close the circuit. (This was afterwards abandoned.) A register to consist of an electro-magnet, "made in any of the usual modes of forming it," to be applied to a short bar of iron at such a distance that the electro-magnet will readily attract it, and to which one end of a lever is fixed with a pencil or other marking material. This is used to mark paper upon a cylinder made to revolve by clock machinery. An alarm apparatus is also mentioned—a method of changing the poles of the magnet after every stroke of the lever—a vocabulary of words—and modes of laying the conductors.

He states some of the common modes of insulating the wires. "When through the air, they may be insulated by a covering that shall protect them from the weather—such as cotton, flax, or hemp—and dipped into any solution which is a non-conductor, and elevated upon pillars."

"What I claim as my invention and desire to secure by "letters patent and to protect for one year by a caveat is a "*method of recording* permanently electrical signs which by "means of metallic wires or other good conductors of electri-"city, convey intelligence between two or more places."

Nothing is said in this document about any mode of renewing or strengthening the currents of electricity either by

combined or relay circuits, or office or local circuits, or in any other form.

Mr. Morse first applied for a patent here on the 7th of April, 1838. On the 13th of May, 1838, he requested the commissioner of patents to delay issuing the letters patent until after advices from him in Europe, whither he was to sail the next day. Nothing more was done for two years: when Morse again applied for his patent, and a correspondence took place between him and the commissioner. The specifications were withdrawn for amendment, and underwent various alterations; a fresh oath was taken 29th May, 1840, and the corrected specification returned to the office; when the patent was issued.

Upon this state of facts a question has been raised as to which is the true date of the application for the patent, it being contended that an application once filed cannot be suspended, while the applicant goes abroad and ascertains the result of foreign skill and invention—that the application cannot be renewed after his return with an amended or altered specification, and yet be treated as filed in its first shape at the date of the original filing.

Prof. J. Henry, in a deposition made in March, 1850, states of Morse as follows:

"'Shortly after my return from Europe, in the autumn of 1837, I learned that Mr. Morse was about to petition Congress for assistance in constructing the electro-magnetic telegraph. Some of my friends in Princeton, knowing what I had done in developing the principles of the telegraph, urged me to make the representation to Congress, which I had expressed some thoughts of doing, namely, that the *principles of the electro-magnetic telegraph belong to the science of the world*, and that any appropriation which might be made by Congress should be as a *premium for the best plan* and the means

of testing the same *which the ingenuity of the country might offer.* Shortly after this I visited New York, and there accidentally made the personal acquaintance of Mr. Morse. He appeared to be an unassuming and prepossessing gentleman, *with very little knowledge of the general principles of electricity, magnetism, or electro-magnetism.* He made *no claims,* in conversation with me, *to any scientific discoveries, or to any thing beyond his particular machine, and process of applying known principles to telegraphic purposes.* He explained to me his plan of a telegraph with which he had recently made a successful experiment. I thought this *plan better than any with which I had been made acquainted in Europe.*

"'I became interested in him, and instead of interfering with his application to Congress, I gave him a certificate in the form of a letter, stating my confidence in the practicability of the electro-magnetic telegraph, and my belief that the form proposed by himself was the best that had been published.

"'Mr. Morse subsequently visited Princeton several times to confer with me on the principles of electricity and magnetism, which might be applicable to the telegraph. I freely gave him any information which I possessed.'"

In response to Morse's petition, Congress appropriated $30,000 for the purpose of testing the practical application of his telegraph. "Thus enabled to prosecute his favorite theme with a freer element and more liberal spirit of investigation, he had the great gratification to exhibit to the American people his invention, working in an eminently successful manner, for a distance of forty miles, between the cities of Baltimore and Washington, in the month of June, 1844." (Turnbull, p. 49.)

It is a remarkable fact, that even after practical forms of the electric telegraph had been perfected in different parts of Europe, very little assistance was afforded by capitalists in

building lines. The same want of enterprise was manifested in this country. Morse obtained his patent in June, 1840, and yet we find nothing done, not even a few miles of wire put up, until after Congress had made the grant before referred to.

The success, however, of the short lines built in England and Bavaria, was sufficient to make it appear that the electric current might be transmitted to great distances at a moderate expense. It was found that wires suspended in the air were sufficient conductors without any insulation, except when in contact with the supporters. But still it was doubted whether the discovery could be made available and profitable for business purposes, and therefore capitalists in this country refused to invest their money in constructing telegraph lines either for the needle telegraph or Morse's. Mr. Morse complained bitterly of this apathy, and in a letter dated May 2d, 1840, addressed to Mr. Ellsworth, Commissioner of Patents, mentions the fact that the apparatus of Wheatstone had then been "carried into operation by a wealthy company for thirteen miles" in England, and that the telegraph of Steinheil, at Munich, was adopted and was carried into effect by the Bavarian Government. Morse, in this letter, insists that those systems are inferior to his own, yet we find that Wheatstone's telegraph is still used in England, with of course various improvements suggested by experience.

Although the principal patent of Wheatstone and Cooke has expired, and there are great rival Telegraph Companies in England, and no legal obstruction to the use of Morse's machine, yet the needle telegraph in various forms is preferred to that contrivance. Morse's first patent was taken out on 20th June, 1840. It was for "a new and useful *improvement* in the mode of communicating information *by sig-*

nals by the application of electro-magnetism." In his specification he stated that he had "invented a new and useful *machine and system of signs* for transmitting intelligence between distant points by the means of a new application and effect of electro-magnetism in producing sounds and signs, or either, and also for *recording* permanently by the same means, and application, and effect of electro-magnetism, any *signs* thus produced, and representing intelligence, transmitted as before named between distant points." He called his invention the "American Electro-Magnetic Telegraph," and declared that it consisted of eight parts, which he described.

On 15th January, 1846, this patent was surrendered on account of alleged defects in the specification, and a new patent was issued in its stead, to run from the date of the first. In the specification the patentee states that he has "invented a new and useful *apparatus for and system of transmitting intelligence* between distant points by means of electro magnets, which put in motion machinery for producing sounds or signs, and recording said signs upon paper," &c.

In the summary of his claim he refers to the previous discovery and use of "the deflective force of a current upon a magnetized bar or needle," and states that the "deflections thus produced were the subject of inspection, and had no power of recording the communication." "I therefore characterize my invention as the first *recording* or printing telegraph by means of *electro-magnetism. There are various known modes of producing motions by electro-magnetism*, but none of these have hitherto been *applied* to actuate or give motion to printing or *recording machinery*, which is *the chief point of my invention and improvement*."

On 13th June, 1848, this patent also was surrendered on the ground that the specification was defective, and a new patent taken to run from the date of the first. In the sche-

dule reference is made to the previous invention of the needle telegraph, and it is stated that the deflections of the needle "required to be noted by ocular inspection at the instant the sign was made. By my invention the intelligence can be transmitted and imprinted on paper or other suitable substance," &c.

In his claim he refers again to the use of the needle telegraph prior to his invention, and says that "the galvanic current had been used to deflect a magnetized bar or needle, and that the deflections thus produced were the subjects of inspection, and had no power, or were not applied, to record the communication."

Mr. Morse also obtained, in 1846, a distinct patent for an improvement in the mode of strengthening the current in the receiving offices, which is referred to as the local circuit patent. Similar contrivances are included in the patent granted in England, to Wheatstone, in 1837, and to Davy, in 1838. In May, 1849, Morse also obtained a patent for a mode of recording telegraphic signs upon paper chemically prepared.

It was at first supposed that it would be found in practice very advantageous to have signs of letters permanently made on paper. But we find that the advantage of recording mere signs is not universally acknowledged, and that even parties who have purchased from Morse the right to use his system have discontinued the recording of dots and dashes—the great feature of Morse's invention, and that which distinguished it from the needle telegraph.

The Company owning the telegraph line running from Buffalo to Milwaukie, called the Erie and Michigan Telegraph Company, working under Morse's patent, have for some time past discontinued the practice of recording the signs produced by the process above mentioned, and have instead thereof received their messages by sound. This they have done for the

last two years without interruption, having found that they could receive three messages by sound in the same time which would be occupied in receiving two under the other system; and, moreover, that in receiving by sound they made fewer mistakes than they were liable to in the use of the dots and dashes, and also dispensed with some of the operators.

The mode of receiving messages by sound is very simple, and one operator is sufficient. The operator sits by his table in any part of the room where the message is received, and writes it down as the sounds are produced. The different sounds are made by the striking of the pen lever upon a piece of brass: thus, three raps in rapid succession are made for the letter A, two raps, an interval, and then two raps more, are made for B, and so forth.

The reasons given in England for preferring the needle telegraph to Morse's are, that there is more liability to error in the latter system, and that in rainy and foggy weather, when the electric current is weak, it is easier to deflect the needles than it would be to make the marks on paper.

Turnbull, in his Introduction (p. 5), says: "In regard to rival claims of the first discovery of the electro-magnetic telegraph, I have endeavored to follow the rule of its first publication; as, for instance, although Steinheil's telegraph is stated to have been in operation in the early part of the year 1837, still there was no published account of it until July, 1837, so that I have placed Morse's as the first electro-magnetic telegraph, his publication being in April, 1837."

The "rule" appears to be a fallible one, as different forms of the electro-magnetic telegraph might have been in public use for years without a printed description of the apparatus having been published. Besides there was nothing that could properly be called a "publication" of Morse's system at the date mentioned.

Dr. Turnbull, in the passage above quoted, is referring only to the species of electric telegraph known as the electro-magnetic telegraph, and must be understood as confining himself to that particular kind of the electro-magnetic telegraph by which the intelligence sent is permanently marked or recorded, for we have seen that he describes a variety of electro magnetic telegraphs employing the deflection of small bars of iron to make signs. And there is indeed no question made about the priority of the needle or pointer telegraph, which is an electro-magnetic telegraph. Steinheil's electro-magnetic signal and marking telegraph clearly preceded Morse's caveat, and various chemical marking telegraphs had preceded Steinheil's.

The publication of Morse's telegraph stated to have been made in April, 1837, was a published description in general terms of a projected telegraph, not of a telegraph in existence. The so-called "publication" does not describe Morse's apparatus at all, although he was the person referred to by the words "the gentleman of our acquaintance." It does not describe an electro-magnetic telegraph, but refers to *any kind* of a twenty-four wire telegraph. For years before this it had been common to publish from time to time, not mere vague allusions of this kind, but specific descriptions of various sorts of electric telegraph apparatus.

The following is the publication referred to. It appeared in the New York Observer, April 15th, 1837, at that time edited by Mr. Morse's brother, and it would appear from this publication that Mr. Morse had not made much progress at that time, although a great variety of forms of the electric telegraph had been proposed in Europe, some of which were patented and introduced into public use long before Morse completed his apparatus.

From the New York Observer, April 15*th*, 1837.

"We know nothing of the telegraph of Messrs. Gonon and Servell, except what is related in the above paragraph; but we do know that *a gentleman of our acquaintance, several years since, suggested* that intelligence might be communicated almost instantaneously, hundreds, if not thousands of miles, by means of very fine wires, properly coated to protect them from moisture, and extending between places thus widely separated. It is well known that the electric fluid occupies no perceptible time in passing many miles on a wire; and if it is possible, by connecting one end of the wire with an electrical or galvanic battery, to produce *any sensible effect whatever* at the other, it is obvious that if there are *twenty-four* wires, each representing a letter of the alphabet, they may be connected with the battery successively in any order; and if so conducted in the order of the letters of any word or sentence, that word or sentence could be read or written by a person standing at the other end of the wires. All the letters of a paragraph in a newspaper could thus be touched successively by a man in Philadelphia, and the contents, verbatim et literatim, be conveyed to New York as fast as a compositor could set up the type! It is not impossible that the time may be near when speeches in Congress, taken down by reporters, and conveyed by these "electric telegraphs" to New York or New Orleans, may be in type, printed, circulated, and read, within a few hours after the voice of the speaker has ceased at Washington. *The wires necessary for a distance of a hundred miles need not weigh many pounds, and if inclosed in an India rubber tube, and supported on high poles* erected along the route at intervals of four or five hundred feet, could be extended through an immense distance at a trifling expense. The feasibility of the project depends *entirely upon the prac-*

ticability of producing any sensible effect at one end of a long wire by connecting the other end with an electrical or galvanic battery."

Dr. Turnbull says (page 46) that Morse's instrument "was *partially* described in Prof. Silliman's Journal of October, 1837, which was afterwards copied in the November number of the Journal of the Franklin Institute of the same year, and the London Mechanic's Magazine of February, 1838."

These were the earliest publications, and at that time electric telegraphs, pointing and marking, electro-magnetic and chemical, were used, patented and commonly known in various parts of Europe. In June, 1837, Wheatstone patented his needle telegraph in England. In July, 1837, Steinheil's line from Munich to Bogenhausen, is described in a printed publication as being then in full operation with three stations in the circuit, and Dr. Steinheil himself states that his apparatus had been in operation on that line 12 months before. The apparatus was probably made ready for use at least as early as the year 1835, as a line would not have been constructed until after the apparatus had been completed and tried. Mr. Morse saw this line in the year 1838, about two years before he got his patent.

Dr. Steinheil did not claim that his apparatus was perfect, but on the contrary expressed the opinion that the motive power having been discovered by scientific men, it would be easy for mechanics to devise better contrivances than his own. Mr. Morse's recording apparatus, in its present improved state, is probably superior in some respects to that used by Steinheil in 1836, but the question mooted by Dr. Turnbull as to which should be considered the first in the order of date is obviously too plain for controversy, if we take the time when each invention was *consummated*.

At one time Morse claimed to be the first who conceived the idea of transmitting intelligence by means of the electric telegraph. But Dr. Jackson in his correspondence with Mr. Morse in 1837, on the subject of their respective claims to be considered the inventors of that form of the telegraph which Morse then preferred, disclaimed the idea that either of them could set up a claim to the discovery of the electric telegraph. The following is an extract from a letter from Morse to Dr. Jackson, dated New York City University, September 18th, 1837.

"I asked you if there was not some mode of decomposition which could be turned to account. You suggested the following experiment, which we agreed should be tried together, if we could meet for that purpose. It was this: to decompose, by the electricity, Glauber salts, upon the paper which was first to be colored with turmeric. This, to me, seemed so simple and easy a mode, that I fell in with the idea, and we agreed to try this experiment as soon as possible after our landing.

"In my occasional visits to Boston, since my return from Europe, I have always endeavored to see you, and never saw you, as you well know, without introducing the subject of the telegraph, and expressing a wish that the experiment we had talked of might be tried. You were always otherwise busily and necessarily engaged, and the *experiment was never tried.*

"I really do not see the ground of your claim to be a mutual discoverer, even if we had tried the experiment proposed and it had been successful. This fact would not have constituted you a mutual discoverer, but it might have made you a partner in a certain sense in the invention.

"The *discovery* is the original suggestion of *conveying intelligence by electricity.* The *invention* is devising the *mode of*

conveying it. The discovery, so far as we alone are concerned, belongs to me, and it must of necessity belong exclusively to one; and if by an experiment which we proposed to try together, we had mutually fixed upon a successful mode of conveying intelligence, then might we with some propriety be termed mutual or joint inventors. But as we have neither tried any experiment together, nor has the one proposed to be tried by you been adopted by me, I cannot see how we can be called mutual inventors."

It appears clear from this letter that Mr. Morse had given himself but very little trouble about the electric telegraph from the year 1832, up to the time when scientific researches and experiments in Europe had removed the difficulties which had theretofore prevented the establishment of the electric telegraph for ordinary commercial purposes. Indeed this letter shows that Mr. Morse had not even tried the simple experiment referred to in the letter, but that he deferred doing so from time to time until Dr. Jackson should have leisure to try the experiment with him.

The claim of Mr. Morse to "*the discovery*" shews that up to September, 1837, he had read very few, if any, scientific works on the subject of electricity, for if he had been acquainted with the history of the electric telegraph, or even if he had made any enquiries about what had been done in his own neighborhood, he could not have supposed that "the original suggestion of conveying intelligence by electricity" had been made in the year 1832. To the above letter Dr. Jackson sent a reply, dated Boston, November 7, 1837, which contains the following passage:

"I never lost sight of the Telegraph, and have done more towards it than you are perhaps aware. I do not know how

or when you used the electro-magnet for marking, but I have proof enough to show that I had produced a lever-beam motion with mine for that purpose as long ago as the spring of 1834, and, as I wrote in my last letter, I could mark in real type.

"I am certainly desirous of doing you justice to the fullest extent, and have always spoken of your merits, as I hope I shall always have occasion to do. I am also anxious that our country shall bear a due proportion of honor in every useful invention, when she deserves the credit by the labor of her men of genius. But I will not do wrong to any one, either for man, friends, country, or myself. Honor to whom honor is due, shall be my motto, and I must, I believe, fail in this duty, if I should say that the first idea of an Electro-Magnetic Telegraph was conceived by an American citizen. I have searched the archives of science, and find that the first idea of such an instrument was conceived by Soemmering, who proposed an Electro Magnetic Telegraph. Oersted, of Copenhagen, also invented one. Ampère says it is easy to construct an Electro-Magnetic Telegraph. (See Ampère, Exposé des Nouvelles Découvertes sur l'Electro-Magnetisme. Paris, 1822, Page 71.) The discovery is not, then, to be claimed by us. I have invented a new instrument: so perhaps have you, for I do not yet know what your new one is, since you say I have not seen it, nor heard about it beyond your announcement. If yours is new, I congratulate you upon the invention, but I can give no certificates beyond what you will find in this letter.

"Most respectfully your friend,

"C. T. Jackson.

"P. S. I did not read this in Ampère until about three years since, although I have owned the book since 1832; and when I saw you last I forgot to mention to you that he had

conceived the idea of such a telegraph. I had read portions of the book before, but not that section."

Mr. Morse, in a letter to the Secretary of the Treasury of the United States, dated September 27, 1837, says, that it occurred to him in the year 1832, that if the presence of electricity could be made visible in any part of the circuit of wires, "it would not be difficult to construct *a system of signs* by which intelligence could be instantaneously transmitted." "Yet from the pressure of unavoidable duties I was compelled to postpone my experiments and was *not able to test the whole plan until within a few weeks*." He adds that he expects to have a complete apparatus by the 1st of January, 1838.

In the meantime other persons had *completed* their apparatus in different parts of Europe. Patents had been applied for, specifications duly filed, and lines actually constructed and put in operation. Whether after all these things had been done Mr. Morse selected the best of the various mechanical contrivances for the Telegraph which had been theretofore used, published, or suggested, is a question upon which there has been much discussion and difference of opinion.

The first experiments were made by Mr. Morse, in the fall of 1837, over short lengths of wire, in the New York University. Much more extensive experiments had been tried in the neighborhood of New York as early as the year 1828, by Mr. Dyer.

Steinheil's telegraph was *in operation* on a line constructed in the early part of the year 1836; Morse's was not in operation till June, 1844. It is incorrect to take in one case the period when the first crude project was published, and in the other, the period when the system was put into practical operation between different towns for business purposes.

As to the needle telegraphs, there is no question about

priority, and Morse in his patents refers to them as having been invented and published anterior to his invention. He says of them, that they did not record the signs, whereas by his system dots and straight lines are to be made on paper.

Of course it is of no consequence to the public whether the instantaneous transmission of intelligence is effected by signs or sounds, dots and dashes, or plain letters. The material question is which is the best system in practice, and the least liable to error.

There is a disposition in some quarters to exaggerate the importance of the difference between sounds and signs in the telegraphic art. The actual fact appears to be that there is no permanent stopping place between the pointing and the printing telegraph. If mere simplicity is to be regarded the needle telegraph is what is required; but if great rapidity and freedom from error are required, then no system by which mere signs are made by repeated manipulations will be treated as sufficient.

The following article from the American Telegraph Magazine, for January 31, 1853, describes one of the best modes of telegraphing by sounds:

The Talking Telegraph—Sounds vs. Signs and Signals.

" With all proper reverence for the respective merits of recording and signalizing Telegraphs—without any disparagement to the ingenuity or efficiency of either of those different modes of electric intercommunication—we must confess that we have witnessed nothing in the practical management of telegraphic business, that interested us more than an exhibition which we recently witnessed at the Cleveland junction office of several western lines, constructed and managed by Col. Speed and J. H. Wade, Esq.

" We refer to the admirable management whereby all the

business at that important junction is transacted (accurately and economically, "as we are informed and believe") by the agency of *sounds* instead of signs—a sort of "talking Telegraph," which is so well understood by *all* the officers on duty there, that although there were six instruments at work while we were temporarily present—making a clicking noise reminding one of a watchmaker's shop—a sort of Babel-like confusion, which would seem utterly chaotic to the uninitiated, or even to ears not thoroughly practised amid the conflicting sounds of so many instruments—although there were six instruments at work, we repeat, in one small sized office, there was such apparent order in the transaction of business, that we were not surprised when Col. Speed informed us that this mode of telegraphing had been used at that important station and at several other offices on the Erie and Michigan Line during the last two years; in all which time, the Telegraphers preferred to dispense entirely with the *recording* apparatus, relying wholly upon the ticking of the instruments—upon SOUNDS, and not upon SIGNS.

"Many—perhaps we might correctly say most—Telegraphers can "read" more or less readily by sounds, and therefore *that* is not the subject of our wonder. But we were surprised to see the *whole* business of extended lines, at a junction so important as Cleveland, transacted *exclusively by sound*, without any use of recording apparatus—transacted satisfactorily, too, amid the apparent confusion incident to the clicking of so many instruments in such close proximity."

Mr. Morse claims to be the inventor of the first marking Telegraph. He states in a letter dated December, 1852, published in the American Telegraph Magazine, that in November, 1835, he made a telegraph in the New York City University, and he contends that at that time " the

child was born, and breathed and spoke." We have seen that he did not file a caveat till October, 1837, and that he then distinctly stated that the invention was not completed, and that he required time to complete it. He argues, in the letter just referred to, that the date of Steinheil's invention must be taken to be—not the time when he first privately shewed some friends some crude and incomplete apparatus—but the time when a line was "in public operation between Munich and Bogenhausen."

Morse in his deposition in the Bain case says,

"From the year 1832, to the latter part of 1835, my profession led me from place to place, affording me little or no time to experiment upon my conception of an electro-magnetic telegraph, although I never lost faith in its practicability, nor abandoned the intention of testing it as soon as I could command the means. In the year 1835, I was appointed a Professor in the New York City University, and about the month of November of that year I occupied rooms in the University buildings.

"There I immediately commenced, with very limited means, to experiment upon my invention."

He describes a machine "made up of an old picture or canvas frame fastened to a table, the wheels of an old wooden clock moved by a weight to carry the paper forward," &c.

"With this apparatus, rude as it was and completed before the first of the year 1836, I was enabled to and did mark down telegraphic intelligible signs, and to make and did make distinguishable sounds for telegraphing, and having arrived at that point, I exhibited it to some of my friends, *early in that year*, and among others to Professor Leonard D. Gale, who was a colleague Professor in the University."

"*Up to the autumn of* 1837, *my telegraphic apparatus existed in so rude a form, that I felt a reluctance to have it seen.*"

"My means were very limited—so limited as to preclude the possibility of constructing an apparatus of such mechanical finish as to warrant my success in venturing upon its public exhibition. I had no wish to expose to ridicule the representative of so many hours of laborious thought. Prior to the summer of 1837, at which time Mr. Vail's attention became attracted to my telegraph, I depended upon my pencil for subsistence.

*   *   *   *   *   *

"In 1836, and the early part of 1837, I directed my experiments mainly to modifications of the marking apparatus, contrivances for using fountain pens, marking with a hard point through pentagraphic or blackened paper, varying the modes of using and moving the paper, at one time on a revolving disc spirally from the center, at another on a cylinder, by which means a large, ordinary sheet of paper might be so written upon that it could be read as a common-place book and bound for reference in volumes; and in devising modes of marking upon chemically-prepared paper. As my means and the duties of my profession would admit, the spring and autumn of 1837 were employed in improving the instrument, varying the mode of writing, experimenting with plumbago and various kinds of ink or coloring matter, substituting a pen for a pencil, and devising a mode of writing on a whole sheet of paper instead of on a strip or ribbon; and in the latter part of August, or the beginning of September of that year, the instrument was shown in the cabinet of the University to numerous visitors, operating through a circuit of 1700 feet of wire running back and forth in that room."

From these extracts it appears that Prof. Morse's exertions were mainly directed to certain *mechanical contrivances* by no means complicated, but not being much of a mechanic, theoretically or practically, he made but slow progress. As

soon as science and invention had demonstrated the practicability of producing mechanical effects at great distances by means of electric currents either with or without the electro-magnet, the electric telegraph became inevitable, and various forms of the telegraph were also inevitable. Any ingenious person could suggest and put in operation various practicable forms. One inventor would avail himself of the deflection of the needle, another of the property of the electric current to decompose salts, another of the mechanical power of the electro-magnet. Morse preferred the latter, and invented or adopted one of the various forms in which that power could be usefully applied for the purpose, and he invented or adopted an alphabet of signs.

As to the making of intelligible marks by the action of the electric current on chemically prepared paper, that had been done by many persons years before Morse had heard of the electric telegraph. "In 1830, Booth, in Dublin, explained fully how electro-magnetism could be used to telegraph at a distance, and cause *marks to be made by the fall of the armature* from the horse-shoe magnet when the current was broken." (*Appendix to Turnbull's Lectures*, p. 31.)

It was shown by Faraday in 1833, (see Faraday's Researches,) that a current from even a single pair of plates was sufficient to make such marks, and to accomplish them he used a single wire touching the paper, and making marks whenever the contact was made. This was a well-known mode at the time of exhibiting the chemical effects of the galvanic current. At an early period patents for this mode of telegraphing were taken out in England.

In 1827 or 1828, Dyer constructed a telegraph line on Long Island. He used common electricity and not electro-magnetism, and but one wire, which operated by a spark which, after going through paper chemically prepared so as

to leave a red mark on it, passed into the ground, without a return circuit. The difference of time between the sparks was, by an arbitrary alphabet, to signify different letters, and the paper was to be moved by the hand, while the telegraph operated, though machinery was contemplated to be introduced for that purpose.

In July, 1838, a patent was granted in England, to Mr. Edward Davy, for a marking Telegraph. He used the decomposing action of the galvanic current to produce marks upon chemically prepared cloth or other material. As to the practical difference between dotting and pointing telegraphs, see ante, page 13.

Many of the chemical telegraphs were marking or permanently recording telegraphs. In some, even of the earliest contrivances, combinations of dots made by the electric spark served as signs of letters. Morse, to make his alphabet, adopts horizontal lines of unequal lengths, as well as dots and makes these marks with a pricker, instead of using the direct action of the current. By his system patented in 1849, he dispenses with the pricker, and marks the dots and dashes on chemically prepared paper by the direct action of the current.

We have seen that the motive power of electro-magnetism was *actually applied* in the telegraphic art as early as 1833, by Gauss and Weber, upon a line of electric telegraph, and that, afterwards, other persons, but especially Steinheil, in '36, and Cooke and Wheatstone in '37 applied the same power upon telegraph lines, using different mechanical contrivances for the purpose of making intelligible signs at a distance. Steinheil did not use in his marking telegraph the motive power of electro-magnetism in the same way as Morse does; the former made his marks with small electro-magnetic bars of iron, each having a small tube holding ink, but Morse uses an electro-magnet to attract a piece of iron (called a

keeper or armature) to which is attached a pricker, with which indentations are made on paper. The machinery is not identical in the mode of operation, but the motive power of the electro-magnet is used in both cases for the purpose of marking signs.

The use of an electro-magnet, with an armature, was suggested by Booth in 1830, and by Prof. Henry in 1833. After repeated experiments, Professor Henry, by means of an intensity battery of his own arrangement, succeeded in sending the electric current through a long circuit, without any perceptible diminution of magnetic power. His experiments and their results were made public in 1831, in Silliman's Journal. In the same publication he announced the applicability of his discovery to the project of the telegraph. In his lectures from the chair of Natural Philosophy, in Princeton College in 1833, and in every subsequent year during his connection with the institution, he mentioned the project of the electro-magnetic telegraph, and explained how the electro-magnet might be used to produce mechanical effects at a distance adequate to making signals of various kinds.

But neither Booth nor Henry contrived a system of signs adapted to that mode, nor did they apply clock-work to move the paper and receive the marks: it remained for others to do these things and perfect the mechanical details, from time to time as experience might dictate.

It has seemed surprising to many that the electric telegraph was not introduced into public use soon after it was discovered that an electric current might be generated and instantaneously transmitted through wire. But the fact is that great discoveries had to be made in the means of generating electricity, so as to secure a steady flow of the current before electric telegraphs could be brought into profitable use or business purposes. Moreover, before the discovery that,

gutta percha was a complete insulator, the attempts made to lay down conductors beneath the surface of the ground were only partially successful, and it was not at first known that conductors of great length suspended in the air would require no special insulation. It was supposed that the current would be dissipated in the course of a few miles if the wire were not covered with some insulating substance. This was Morse's idea when he filed his caveat in Oct. 1837, for he therein assumes it to be absolutely necessary to cover the wires if they should be suspended in the air.

Weber concluded, in 1833, that the air was a sufficient insulator. Steinheil, in 1836, acted upon that opinion, and indeed, formed the conclusion that we should never succeed in laying down conductors beneath the surface of the ground that would be sufficiently insulated, the ground being always damp. The wires of the first telegraph constructed in England in 1837, were insulated in tubes by means of a mixture of cotton and India rubber, and the prepared wires were passed through iron pipes, which on some parts of the line were buried beneath the ground and in others raised above it. The wires were afterwards elevated on wooden posts, as the moisture affected the wires and destroyed the insulation.

Morse, in 1843, not being aware of these experiments, as it would appear, adopted an inferior mode of laying his conductors under the ground, which, after considerable expense had been incurred, was abandoned, and the conductors were then suspended by him in the air, with insulators at the supporters, according to the custom in Europe.

Judge Woodbury makes the following remarks on these facts :—" Nor did Morse use poles or posts at first in 1844 when constructing a telegraph between Baltimore and Washington. Though they were used by Steinheil before 1837, and by Dyer even in 1828, and were suggested to Morse as

early as 1838 by Prof. Henry, yet *Morse thinks he himself invented them!*" for which the Judge quotes Morse's deposition.

Since the discovery that gutta percha is a complete insulator, many subterranean telegraph lines have been constructed in various parts of Europe, and submarine telegraph cables have been invented and brought into successful operation.

It must not be supposed that Mr. Morse claims in his patents to have been the first to invent or to put in practice an electro-magnetic telegraph. No such claim is made in his patents, original or re-issued: on the contrary, he therein disclaims the invention of the needle telegraph, and in the Bain case he gave his testimony, in reply to cross interrogatories, as follows, (*Am. Tel. Mag.*, vol. I. 109.)

"*Fifteenth cross interrogatory.* Do you claim to have invented the electro magnet? Ans. I do not.

"*Sixteenth.* Do you claim to have discovered that an electro-magnet will attract an armature of iron or steel? Ans. I do not.

"*Seventeenth.* Do you claim to have been the first inventor of the combination of an electro-magnet with a circuit of conductors? Ans. I do not.

"*Eighteenth.* Do you claim to have first discovered that the breaking and closing of an electric or galvanic circuit, having within it a generator of electricity or galvanism, will cause an alternate flow and cessation of a current of electricity or galvanism? Ans. I do not.

"*Nineteenth.* Do you mean to say that you were the first to discover that when an electro-magnet is connected with and forms a part of such circuit, the magnet will be made attractive and non-attractive, as the current flows or ceases to flow? Ans. I do not.

"*Twentieth.* Do you mean to say that you were the first inventor of the combining an electro-magnet and an armature in a circuit of electric or galvanic conductors? Ans. No, not generally in the abstract; but I do claim to be the first inventor of combining an electro-magnet and an armature *as described in my letters patent*, and of combining this combination with a circuit of electric or galvanic conductors."

Whenever Mr. Morse or the witnesses in the cases which have been litigated speak of his being the inventor of "*the* electro-magnetic telegraph," they speak only of his telegraph which has been dignified by that name, and do not mean to say that there were no electro-magnetic telegraphs prior to his invention.

Bain's Electro-Chemical Telegraph, patented in this country in 1849, is for making signs of letters similar to those used in Morse's system, by the action of the galvanic current on paper chemically prepared, without the intervention of any mechanical contrivances, worked by the motive power of electro-magnetism.

When Bain applied for his patent, it was resisted by Morse, not on the ground that he was entitled, under his first patent, to a monopoly of the art of recording such signs by electricity by all means, modes, or methods, whether described in his patent or not, but upon the ground that he had invented the same system as Bain's, and had filed a caveat before Bain's application. Bain had obtained a patent in England on 12th December, 1846, and on 27th January, 1847, a caveat for a similar invention was entered by Morse in the secret archives of the office at Washington. It was held by the Attorney-General that Bain, being an alien, could not be allowed to prove that he was the inventor before the date of his patent, but that Morse might show that he was acquainted with the invention before that date, and thus sustain his caveat. Ac-

cordingly, Morse's son was called to prove that his father had explained to him the same invention before 12th December, 1846.

A patent was granted to Morse, whereupon Bain appealed, in the mode prescribed by the act of Congress, to the Chief Justice of the District of Columbia, who decided that both parties were entitled to patents, which were granted accordingly.

A district Judge of the U. S. has since decided that Bain's patent was invalid, on the ground that Morse was entitled, under his first patent, to a monopoly of the entire art of recording signs of letters.

Bain's Chemical Telegraph is extensively used in England; great improvements have been made by him since the date of his patent.

It may be asserted without fear of contradiction that Morse did not invent the electric-telegraph, or the electro-magnetic telegraph, and that he was not the first to publish to the world the form of either of those modes of telegraphing. Nor did he take out the first patent for either of them; nor was he even the first to obtain a patent in this country for either of them; nor was he the first to build an electric or electro-magnetic telegraph line for business purposes. There is no dispute about any of these particulars, nor is it pretended that he made any scientific discovery in electricity or electro-magnetism. What, then, are his admitted claims, and on what points is there any dispute? It is admitted that he was the first to build a long telegraph line *in this country*. This was three years after he got his patent, and many years after electro-magnetic telegraph lines had been built in other parts of the world. The claim which is disputed, is the claim that before his invention there had never been used or known any mode of *marking* intelligible signs at a distance by means of

electric currents. It is conceded, however, that he was the first to perfect and put in operation the peculiar apparatus described in his patent.

He insists that the pricker apparatus is superior to that of the needle or pointer, which is denied by very competent judges. It seems that there is in reality no permanent stopping place between pointing to letters and the printing of them, and that the systems by which mere dots or scratches, for signs of letters are made, may be classed with a hundred other *evanescent* forms of electric telegraph apparatus which have been in favor for a time, but ultimately discontinued.

Morse also claims to have invented what he calls "the local circuit" and combined circuits," by which the electric currents are used in a peculiar manner.

But the principle of these contrivances was embraced in Wheatstone's English patent of June, 1837, as will be seen hereafter.

Neither in Morse's caveat, dated 3rd October, 1837, nor in the published description of Morse's Telegraph in the Franklin Journal, in 1838, is mention made of any contrivance for bringing into operation a second current by means of the first.

The following is extracted from the report of the Committee on science and the arts, constituted by the Franklin Institute of the State of Pennsylvania, dated February 8th, 1838.

"The Committee on science and the arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for an examination, an electro magnetic telegraph, invented by Prof. S. F. B Morse, of the city of New York, report:

"That this instrument was exhibited to them in the Hall of this Institute, and every opportunity given by Mr. Morse

and his associate, Mr. Alfred Vail, to examine it carefully, and to judge of its operation.

* * * *

"As exhibited to us, it was very satisfactory. The power given to the magnet at the register, through a length of wire of ten miles, was abundantly sufficient for the movements required to make the signals. The communication of this power was instantaneous. The time required to make the signals was as short at least as that necessary in the ordinary telegraphs. It appears to the Committee, therefore, that the possibility of using telegraphs on this plan, in actual practice, is not to be doubted, though difficulties may be anticipated which could not be tested with the trial made by the model.

* * * *

"Doubts have been raised as to the distance to which the current of an ordinary battery can be made efficient; but the Committee think no serious difficulty is to be anticipated on this point.

* * * *

"An experiment is said to have been made on the Birmingham and Manchester Railroad, through a circuit of thirty miles in length.

"It may be proper to state, that the idea of using electro-magnetism for telegraphic purposes has presented itself to several different individuals, and that it may be difficult to settle among them the question of originality.

"The celebrated Gauss has a telegraph of this kind in actual operation, for communicating signals between the University of Gottingen, and his magnetic observatory in its vicinity. Mr. Wheatstone, of London, has been for some time also engaged in experiments on an electro-magnetic telegraph. But the plan of Prof. Morse is, so far as the Committee are informed, entirely different from those devised by other indivi-

duals, all of which act by *giving different directions to magnetic needles, and would therefore require several circuits of wire between all the stations.*" (Turnbull, p. 47.)

It will be observed that the Committee mention that doubts had been raised as to the distance to which the current of an ordinary battery could be made efficient. Of course, if Morse had at that time been thoroughly satisfied that the difficulty suggested could be removed by a relay or local circuit, the report of the Committee would not have been silent on that point.

It had been an objection that a large portion of the current would escape on a long line. This objection is avoided by a simple contrivance by which the current of one battery is used to set off that of a second, the second a third and so on, the last circuit being thereby made as strong as the first. Or what is called a local or office circuit may be used, by which, although the current may be too weak at the office of the receiving station to work the registering apparatus, there is strength enough in the current to bring into play another battery and magnet with which the message is recorded.

Some contrivance of this sort was absolutely necessary in the use of the kind of telegraph selected by Morse, but so slight a current of electricity is necessary to produce chemical action, that the relay circuit or local circuit is not indispensable to the practical working of a chemical Telegraph for some hundreds of miles, and House's axial magnet supersedes the necessity for such contrivances.

The following is extracted from the evidence of Professor Henry, in the Bain case:

"In February, 1837, I went to Europe, and early in April

of that year, Professor Wheatstone, of London, in the course of a visit to him at King's College, London, with Professor Bache, now of the United States Coast Survey, explained to us his plan of an electro-magnetic telegraph, and among other things, exhibited to us his method of bringing into action a second galvanic current. This consisted in closing the second circuit by the deflection of a magnetic needle, so placed that the two ends of the wire of the open circuit, projecting upwards, would be united by the contact of the ends of the needle when deflected. The second circuit was opened by interrupting the current in the first circuit, the needle resuming its original position, due to the attractive force of the magnetism of the earth. I informed him that I had devised another method of producing effects somewhat similar."

He describes the process, and continues—

"The object of Professor Wheatstone, as I recollect it, in bringing into action a second circuit, was to provide a remedy for the diminution of force in a long circuit. My object, in the process I have described, was to cause a large quantity magnet, connected with a quantity battery in a local circuit, to let fall its load by means of a small intensity magnet, and an intensity battery at a distance." * * * *

"I heard nothing of the secondary circuit as a part of Mr. Morse's plan, until after his return from Europe, whither he went in 1838. It was not until after this that Mr. Morse used the earth as a part of the circuit, in accordance with the discovery of Steinheil.

"*I am not aware that Mr. Morse has ever made a single original discovery in electricity, magnetism, or electro-magnetism, applicable to the invention of the telegraph.* I have considered his merit to consist in combining and applying the discoveries of others in *the invention of a particular instru-*

ment and process for telegraphic purposes. I had no means of determining how far this invention is original with himself, or how far much is due to those *associated with him*."

The following is extracted from Dr. Channing's evidence in the Bain case:—

"I have before me a printed copy of what purports to be a deposition made by S. F. B. Morse, in a case brought by F. O. J. Smith, against Hugh Downing and others, and in said deposition on page 52 of the record, I find the following words: "He" (this affiant) "communicated a description of his invention, and exhibited the instrument in operation to the French Academy of Science, at their session, on the 10th of September, 1838, and it was published in the weekly journal of the Academy, called the 'Comptes Rendus,' a few days after. That description, however, did not include the office circuit or receiving magnet, the utility of which was then unknown."

"It will be seen that the date, September 10th, 1838, concerning which this declaration is made, is nearly fifteen months subsequent to the patent of Cooke and Wheatstone, (Repertory of Patent Inventions, London, 1839, Vol. II., new series, p. 1) which includes the Receiving Instrument and Office Circuit; and more than two months subsequent to the patent of Edward Davy, (Ibid. 1839, Vol. XII. new series p. 1) which includes the Receiving Instrument and Local Circuit as well as the principle of 'Relay.' In the description in the Comptes Rendus (Comptes Rendus de l'Academie des Sciences, Paris, 1838, pages 593, 594, 595,) referred to by the said S. F. B. Morse, I find no description of a receiving instrument, or either local circuit or system of relays."

Not the least surprizing fact in the examination of this sub-

ject is the neglect of persons engaged in inventing telegraph apparatus, to make themselves acquainted with the result of the labors of others. Thus we have seen that Mr. Morse, as late as September, 1837, set up a claim to be considered the first who had conceived the idea of an electric telegraph of any description. This assumption he would not have made if he had taken the trouble to read books on the subject, or to make enquiries amongst scientific men either in his own country or abroad. So we find him in Paris in 1838, apparently unaware of the nature of Wheatstone's Patent.

It is true he might not have been able readily to get access to the patent before he left England for France, especially as no classified index was kept at the enrolment office, but he might have ascertained by enquiries in scientific circles in London, what had been done in telegraphing. We are not aware whether the contrivance adopted by Professor Wheatstone was invented by him—it is probable that he was anticipated by many others in what was so simple and obvious.

Morse seems to have confined his claims in Europe entirely to the supposed advantages of his favorite mode of marking signs, without ever adverting to the objections amongst others that this plan required a strong electric current, and moreover demanded a precise appreciation of time even to the tenth part of a second. His original proposition for the use of movable types and a port rule, and that without repeating circuits, was obviously very inferior to other plans then in use.

In the Bain case, Mr. Morse and his partner, Mr. Gale, deposed that a practical mode of communicating the impulse of one circuit to another was invented by Morse as early as the Spring of 1837, and shown then by him to Mr. Gale. But as the caveat dated 3rd October, 1837, and filed on the 6th

of the same month, makes no mention of this or any similar contrivance, it is obvious that Morse had not at that time *matured* the invention of it so as to entitle himself to ask for a patent for it, or even to treat it as one of the characteristics of the proposed and incomplete invention referred to in the caveat.

It appears from the statements above referred to, that he had talked about it and proposed something of the kind, but that he did not follow up the idea; for if he had done so such a leading characteristic of the invention would not have been passed over unnoticed by him in his caveat, his exhibition in Philadelphia, and his description of his invention in Paris.

The specification as amended on his return from Europe, when he renewed his application for the issue of a patent, does contain a description of the contrivance in question.

Before the date of the caveat, Wheatstone's patent was sealed, and before the time when, according to Morse, the utility of the local circuit and receiving magnet was unknown, Davy's patent described but did not claim the local circuit, as that was included in Wheatstone's patent—but Davy described and claimed the relay.

Of course after it had been practically shown how the current might be strengthened, either on the main line or in the receiving office, it was easy enough to apply the principle of the contrivance to produce other effects than those for which it was originally adopted. Wheatstone used it to sound an alarm, but as a slight current sufficed to deflect the magnetic needles, it was not necessary for him to strengthen the current for the purpose of receiving the intelligence sent; whilst on the other hand the local circuit was necessary for Morse's marking telegraph, as it requires a strong current to make the electro-magnet attract the armature to which the pricker is annexed, so that it may make marks on the paper brought

in contact therewith. The *vis inertiæ* to be overcome made the local circuit indispensable for his system. This simple but ingenious contrivance for strengthening the current has been variously applied, and improvements in detail have from time to time been introduced.

Looking at the fact that Morse devoted a considerable portion of his time to the subject of the electric telegraph during the year 1837, it is surprising that he failed to avail himself of the knowledge to be attained from published works in Europe and America, and the experiments tried there and here.

The following is an extract from the evidence of Mr. Avery, in the Bain case. He was employed in constructing the line from Washington to Baltimore.

"The first time that I knew of the invention of the local circuit, was in November, 1843. I do not know that it was suggested to Mr. Morse before he used and applied it, but upon an examination of the patent of Wheatstone and Cooke of 1840, and of the patent of Edward Davy of 1838, I find the local circuit as complete in form and principle as in the patent of Mr. Morse at the present day. I know that Mr. Morse did encounter many difficulties in operating the line of telegraph between Washington and Baltimore during its construction and after its completion, under his patent of June 20th, 1840. Upon making our experiments on the line, *almost every thing was a complete failure.* The original plan of laying the wires in pipes under ground, was a total failure and was abandoned. The instrument made for writing never was used, being found totally useless; it was cut up by me, and part of the materials used by me for making the new improvements. The recording instrument had also to be altered." He also mentions alterations which had to be made in the batteries, relay magnets, &c. before they could be got into practical operation.

He says that when he enquired of Morse at the outset, in November, 1843, how he proposed to conduct his wires on the line, he replied, "that he intended to lay four wire conductors in lead pipes, the pipes to be buried or covered with earth, and that the communication would be transmitted by one circuit and return on the other; and that he intended to use and apply a battery to each circuit. I then informed him that such a plan would never work. Mr. Morse opposed my views and said his plan would work. We proceeded to Baltimore, and about ten miles of the pipe containing the wire was laid and covered up with earth near Baltimore. This plan was abandoned, because I found that the electric current in passing along the wires charged the lead pipes within which the wires were enclosed. I made the experiment and told Mr. Morse the result, and during the experiments with the lead pipes I informed him that in Europe the wires were insulated on poles. The original plan of laying the wires in pipe was then abandoned, and about the 1st of April, 1844, we commenced to put up the wires on poles."

Mr. Avery also states that he invented the lever key now in use for opening and closing the circuit, the original mode of doing so being by a piece of sheet copper, one edge fastened to the table. Avery's lever key is similar to that of Ampère as adopted by Cooke and Wheatstone in their patent of June, 1837.

The apparatus described in Morse's caveat would have been of very little practical utility, without the numerous additions and improvements made after his return from Europe. In the form in which it was presented in England and France, it was far inferior to the systems which had been already introduced in England and Germany, although they were in a state which required various improvements in matters of detail.

In Morse's patent of 1840, he says that "the wires or other metal for conductors were to be insulated by a covering of cotton, flax, or hemp, and dipped in a solution of caoutchouc, &c., whether laid through the air, enclosed above the ground, in the ground, or through the water." Experience in Europe had shown that wires suspended in the air were sufficient conductors without any insulation, except when in contact with the supporters. Morse's patent does not refer to this, but assumes an insulation of the conductors to be necessary throughout. Had he been acquainted with the fact, well known as far back as 1821, that the conducting power of similar metals, for voltaic or galvanic electricity, is inversely as their length and directly as their section, he would never have asserted, in his patent of 1840, that the conductors might be made "of cord or twine, or other substances gilt, silvered, or covered with any thin metal leaf."

As to the mere conception of the idea that marks might be made by the rise or fall of the armature of an electro-magnet, there was nothing remarkable in it, nor was it original with Morse, nor was it at all essential to the success of the electric telegraph. The period when the apparatus was first made, so as to be in a practical working shape, appears to be the year 1844; and yet Morse had only to adopt a mode of breaking and closing the circuit at one end of the line and a contrivance at the other for moving paper regularly to come in contact with a pencil or pricker attached to the armature of a magnet properly adjusted. This, with an alphabet of signs, was all he had to invent or adopt in order to have an electric telegraph different, in some respects, from those previously in use. And yet it was not until 1843 or 1844 that he adopted a good practical mode either of transmitting or registering—his mode of breaking and closing the circuit being novel indeed, but in fact worthless in comparison with

other modes which had been used on telegraph lines in Europe.

We have seen that the *first patent granted in the United States, for an Electric Telegraph, was issued to Wheatstone and Cooke*, on 10 June, 1840, for fourteen years, from 12 June, 1837—the date of the patent granted to them in England. The next was granted to Mr. Morse, in the same month. House's first patent is dated 18 April, 1846.

In England, the vulgar belief is that Wheatstone and Cooke invented the electric telegraph. This idea is founded upon the fact that they first introduced the electric telegraph into general use in that country. This they did without any aid from the government. So in the United States, the common opinion is that Mr. Morse was the inventor of the electric telegraph, because he put up the first telegraph line in the United States for the use of the public. This line, it will be remembered, was paid for by Congress, and was not commenced until the year 1843. Messrs. Wheatstone and Cooke never gave any sanction to the popular delusion in their favor, but confined their claims as patentees to the specific contrivances and improvements invented or adopted and applied by them.

Subterranean and submarine telegraph lines have been constructed in various parts of Europe at great expense, and it appears that the electric telegraph in that part of the world, especially in England, is in a much more advanced state than it is at present in the United States, with the exception of Mr. House's great American invention. This will doubtless be adopted when the recent improvements on his original machine are generally made known. The electric telegraph has recently been greatly extended in England, and prices have been materially reduced.

Morse has, within a few years past, set up a claim under

his patent to a monopoly all the means and processes of marking signs of letters by electricity, however developed, and also a monopoly of all the means by which intelligible sounds can be sent by the electric telegraph. This claim, coupled with that of the local circuit, has had the effect of generally deterring others from taking up the electric telegraph where Morse took it up, and introducing either the old systems or any other to compete with Morse's patents. The claim was even set up in such broad terms as to cover House's printing telegraph, although Morse did not even undertake to show in his specification how plain letters could be printed. The claim was tested in a suit, decided at Boston, in the year 1850, before Judge Woodbury, of the Supreme Court of the United States. That learned Judge reviewed the history of the electric telegraph, as it appeared before him in evidence, and decided that House used nothing which Morse had invented, but only the previous discoveries and inventions of others which Morse had availed himself of. The Judge reviews the opinions of experts as follows:

"It seems thus demonstrable, that all which Morse appears entited to protect as new, is untouched by House.

"If we proceed next to the opinion of experts, whether House infringes on Morse, or, in other words, whether the principle of the two machines be unlike or not, there seems to be a remarkable preponderance in favor of House's machine. Mr. Morse himself is the other way,—a gentleman not educated specially to any branch of science,—but having the general information of a man liberally taught, and a highly ingenious mind. He was a painter by profession, according to his evidence; and beside him regarding House as infringing, is only Mr. Foss, an assistant in working one of his machines, but a baker and grocer till 1845. These are all against

House's machine; and *neither of them seem to be experts*, such as usually are relied on to give scientific opinion rather than mere facts. On the other hand, and that the principles of the two machines are clearly unlike, are numerous experts, including some of the most experienced and talented men in this line of science in the country, and some of them also very practical men. They all, twelve or fourteen in number, unite in the conclusion, that the principle of the two is wholly different.

"Some consider the two as unlike as '*a goose quill is to a printing press.*' And several of them express a decided opinion that House's is superior—some think as a work of science—some as a piece of mechanism, and some as to its practical utility. Though more complicated, its results are in Roman letters, and require no translation; its speed in action is greater; and is not so liable to mistakes in transmitting or construing and copying."

An appeal from this decision was taken to the Supreme Court of the U. S., but dismissed for want of prosecution.

The claim set up by Morse, and the litigation consequent thereupon, has had a very prejudicial effect upon the interests of the public in obstructing the extension of House's Printing Telegraph.

The extent of the patent as claimed by Morse's Counsel in the Boston case, was as follows: "The subject matter is a telegraph for transmitting and recording or printing intelligence at a distance by an application of the motive power of *electro-magnetism to suitable machinery.*" By this he meant *any* "suitable machinery."

"If it was an old application to apply electro-magnetism to a *recording* telegraph, then Morse could only have covered his new means of making the record."

We have seen that the application of electro-magnetism for that purpose was old, but even if it had not been, the patent could not, in accordance with the principles of the patent laws, have been for the general application of that motive power to produce a general result, irrespective of the means used, and the kind of result produced.

The extent of the patent, as claimed by some of Morse's Counsel, in the Bain case, and allowed by Judge Kane, (District Judge in Pennsylvania) was, that Morse was the first to make, by means of electricity, intelligible *marks* signs of letters, and therefore no one should be permitted to mark signs of letters by the use of electric currents, by any machinery or process whatever, and whether with or without the motive power of electro-magnetism !

This was not the ground upon which Bain's claim to a patent was resisted by Morse, nor is it the ground taken by Morse's Counsel in the House case at Boston, and certainly no such claim is contained in the first patent granted to Morse. (See ante.)

Judge Kane says, that there is no material diversity of claim between the original patent and the re-issues made for the avowed purpose of correcting defects in the specifications. If that be so, then the claim in the last re-issued patent is the same as that of the original, viz.: for an "improvement" in the telegraphic art, which improvement consists of the apparatus described, and of that opinion was Judge Woodbury, in the House case.

We have seen that intelligible marks had been made years before Morse's invention, by chemical telegraphs, as well as by Steinheil's electro-magnetic telegraph. And Steinheil, in introducing his marking telegraph, treats the difference between it and its predecessors as a mere improvement in the telegraphic art, *falling within the province of mechanics.*

Judge Kane in his opinion says, there can be no doubt but that Morse's "invention was *consummated* before the early Spring of 1837," and that nobody had at that time *made* a recording Telegraph.

Prof. Morse did not actually make a recording telegraph until 1843–4, but Steinheil had one in actual operation *before* "the early Spring of 1837."

That Morse had *not then consummated* even the idea or invention of his apparatus for breaking and closing the circuit and registering, (all that he had to do) is shewn by his caveat, dated 3rd October, 1837, in which it is stated that the invention was *not then consummated.*

Judge Kane in holding that the patent might legally be for an art generally, on shewing one mode of exercising it says, "And it may be noted as not without interest, that in just accordance with the spirit of the English law cases, the English patents of Cooke & Wheatstone, Davy and Bain, *claim property in the arts*, for which their mechanical devices are respectively adapted, not indeed in so many words, but *in language as unequivocal as that employed by Mr. Morse.*"

It is true that in one sense every patent is granted for an art—the art of doing the thing proposed by the devised method explained to the public in the specification. But this is very different from a monopoly of the art of producing a general or even specific result by all modes whatsoever.

The English patents of Cooke and Wheatstone, Davy and Bain are, in accordance with the spirit of the English law cases, confined to the mechanical devices described in their specifications. In the case of the Electric Telegraph Company *v.* Brett and Little, one of the principal questions was whether the patent granted to Cooke and Wheatstone was for a *combination* of certain mechanical devices, or for several

distinct devices. The Court held that it was for the latter, and upon that ground the plaintiff kept the verdict in his favor. Neither the Court nor the Counsel appear to have supposed that the patent was or could have been for an art in the abstract.

Amongst other objections to granting such a patent, it is obvious that it would give a monopoly of all the means of using the art patented, whether invented by the patentee or others, so that an improvement made by others might be used by the patentee without the consent of the inventor—an advantage which no patentee claims—and yet such would be the legal effect and clear meaning of an *explicit grant of a monopoly* of an entire art, *ex vi termini*, and thus all improvements would be stopped by a system designed to promote inventions. Patents have not been granted in that form since the Statute of Monopolies.

Judge Kane, speaking of the "local circuit," says: "The devices referred to in the patents of Cooke and Wheatstone, and Davy, are at least imperfect *modifications* of the combined series of Mr. Morse's first patent; one of them not improbably borrowed from it."

A simple reference to dates will show that Cooke and Wheatstone could not have made any *modification* of the devices described in Morse's first patent, for that patent is dated 20th June, 1840, whereas the patent of Cooke and Wheatstone is dated June, 1837, and that of Davy is dated July, 1838. The modification appears to have been the other way, for the contrivance described in Morse's patent, is as we have already shown, similar in principle to that of Cooke and Wheatstone.

It has never been disputed that Morse had a right to take out a patent for his mode of marking signs. Judge Woodbury held that "other inventors must take care not to use

any thing which Morse himself invented, but only, like him, use the fruits of their own perseverance and ingenuity."

But it has been contended by Morse's assignees that other inventors had no right to begin where Morse himself began, and introduce other systems of telegraphing, even although they avoided the use of any thing invented by him—that they could not be permitted to produce an effect by the agency of electricity of any kind, directly or indirectly, with or without an electro-magnet, which effect could be described by the same generic term or expression which describes the effect produced by Morse's apparatus.

Thus the making of intelligible punctures and scratches on paper, may be called recording intelligence, and so may the printing of plain letters, although machinery to produce that effect must be as different as that of a steam engine from that of a watch.

This claim was wholly repudiated by Judge Woodbury, as being based on an erroneous assumption of facts respecting the invention, as well as upon a total misconception of the principles, scope and object of the patent laws, and moreover as inconsistent with the patent itself, which was for an improvement in the telegraphic art as described in the specifications accompanying the patent. He held that the reïssued patent was not open to the objection that it claimed more than the original patent, which did not contain words capable of being construed into such a sweeping claim.

The general result, the instantaneous transmission of intelligence by electric currents, was not new when Morse completed his invention. Nor was the particular result the marking of intelligible signs at a distance thereby.

Nor was the application of the motive power of electro-magnetism to produce either the general or the particular result above mentioned. Nor was that application, or any ap-

plication of electro-magnetism, necessary to produce either result.

But the application of the motive power of electro-magnetism, to cause marks to be made by a pencil or pricker at the end of a lever attached to the armature of a horse-shoe magnet appears to have been first made by Morse, for the purpose of an electric telegraph, although that application was not originally suggested by him. At least he appears to have been the first who completed an apparatus for that application. Others may have projected the same thing, but he, according to the testimony, was the first to carry out the idea in practice, so as to be entitled to a patent.

The true date of the invention is the time when he first adapted his invention to use, which must have been some time after the date of his caveat, in which document he states that the invention was then incomplete.

The patent covered the means thus first applied, and the principle of the contrivance. "It would amount to an infringement of such an invention as Morse's, or the patent for it, to adopt his mode of acting, operating, &c., or merely to change it by substituting some mechanical equivalent in a part of it, or altering only the form and proportion so as not materially to affect results, or making any change merely evasive, colorable, and not 'substantial' or 'considerable' in its character." (Judge Woodbury.)

It will be obvious, from what has been already shown of the progress of scientific discovery, that the electric telegraph would long ago have been in public use in this country, if Morse had never existed. But he is entitled to the credit of having persevered in endeavoring to introduce the telegraph into general use, although it was confidently predicted that the business would not pay expenses. He and his friends succeeded in inducing Congress to pay the expense of con-

structing an experimental line between Washington and Baltimore, in 1844. Morse was assisted by Mr. Vail and Mr. F. O. J. Smith, in bringing "the American Telegraph" before the public. Morse's own pecuniary means were very limited; he not having met with much success in his profession as an artist, which he pursued until the summer of 1837, when Mr. Vail joined him in his telegraphic enterprise. Morse was also assisted by Professor Gale, and often consulted Professor Henry.

If Morse had obtained no patent, or had not interested himself in the subject, no doubt others would have availed themselves of the actual establishment of the electric telegraph lines in England and elsewhere, before referred to, and even if we had not had the electro-magnetic marking telegraph, with the pricker, and dots, and lines, we should doubtless have had the needle telegraph, or the chemical telegraph, about the same time that Morse's apparatus was put in operation. Either of the above contrivances would have answered the purpose quite as well as the one selected by Morse, and if the public had had nothing to pay for patents, the telegraph lines would probably have been more substantially built, and the tariff of prices would have been lower.

On the principal lines, as much has been paid for the use of Morse's patents, as for the total cost of the construction of the lines. This burthen has been almost too much for the telegraph system in its infancy—the lines have been flimsily built—the stocks of the companies have been too high, and the extension of the business has been restrained by the necessity of charging heavy rates for messages, in order to get dividends on such large capital stocks. In many parts of the country, especially in the south and west, the telegraph lines are but of little practical utility, not being at all reliable. And there is reason to believe that so long as Morse's principal

patent is in existence, the general adoption of other and better systems of telegraphing will be prevented by the influence of the old companies, and by the claims set up under that patent.

A strong instance of the popular delusion in this country, on the subject of the invention of the electric telegraph, is to be found in the abstract of the 7th census in Mr. Kennedy's Report on Railroads and Telegraphs in the United States, (p. 107.) "It is to American ingenuity that we owe the *practical application of the magnetic telegraph*, for the purpose of communication between distant points, and it has been perfected and improved mainly by American science and skill. While the honor is due to Prof. Morse for the practical application and successful prosecution of the telegraph, it is mainly owing to the researches and discoveries of Prof. Henry, and other scientific Americans, that he was enabled to perfect so valuable an invention."

The same document asserts that Electric Telegraphs in England "were first established in 1845," which, as we have seen, is about six years after the first line was constructed there for business purposes. One hundred thousand copies of this report were published by order of the House of Representatives.

Now it has never even been pretended that American ingenuity has supplied any thing towards the practical application of the needle or pointing telegraph, which is one of the various forms of the "magnetic telegraph," and confessedly the earliest of them all. We have seen what scientific researches and discoveries led to the intrduction of the Electric Telegraph, and will conclude by quoting the following passages from Dr. Turnbull's Lectures:

"The electric telegraph has been a long time in advancing

to its present state. It is not the invention of one man or any set of men, nor of one nation, but of many nations, each adding their mite to the noble structure. Its history is based upon two of the most interesting of the physical sciences, those of electricity and magnetism. Had not these sciences been fully investigated, and thousands of laborers spent centuries upon them, we should never have seen an electric telegraph. Had not such men as Oersted, Ampère, Arago, Faraday, and our own Franklin, spent their days in experimenting and nights in studying, we should never have reaped the rich reward of their labors." (Turnbull, p. 3.)

The History of the Electric Telegraph, as detailed in the opinion of Judge Woodbury, of the Supreme Court of the United States, in the case of Smith *vs.* Downing in the U. S. Circuit Court, District of Mass. May Term, 1850.

"Mr. Morse states that the first idea he formed in relation to the subject of communicating information by electricity to a distance, was on board the Sully, on his return from Europe, in the autumn of 1832. But from various obstacles and imperfections in existing batteries, and a want of pecuniary means, and the novelty and complicated nature of the proposed improvements, he was not able nearly to complete it till October, 1837, when he filed a caveat on the subject, and in April, 1838, put his specification and drawings on the records of the patent office, and in June, 1840, took out his first patent.

When his attention was first turned to the subject in 1832, not having before been particularly engaged in scientific pursuits, though possessed of good general information and much ingenuity, (Day's Ev. 92 a. : Prof. Silliman Ev. 94 a.,) he did not appear to know with exactness what discoveries had before been made in the matter, and how far others, by vast ingenuity and science in the same path, had already carried into effect what then struck him as practical and likely to prove highly useful.

Whether he or Dr. Jackson first spoke, on that occasion, of what might probably be done to convert the power of electricity to use in recording ideas, as well as in communicating them to a distance, is disputed. (Jackson Ev. 162, 3, 4.)

It does not seem necessary to settle this point on this occasion; and it is a controversy very unpleasant to discuss, if avoidable, between two gentlemen of such high reputation and public usefulness.

It would seem probable, that, after the matter was broached by some one, Dr. Jackson, from the nature of his scientific studies, fresh from lectures in Paris, with an electro-magnet in his baggage on board, and some recent books treating of some of the operations which had been performed with this power, (Jackson Ev. 187 r., 162 r., 18 r.,) could impart more information in respect to it, and to any probable movement in the use of it. While, on the other hand, it is certain, from what has taken place since, that Mr. Morse possessed the perseverance, industry and skill to go on with inquiries concerning the subject, when once started, till he perfected an instrument or machine to accomplish what was then agitated; and that he is, therefore, under the patent system, alone entitled to be protected as the inventor of what is claimed and described in his specification—so far as it had not been completed before by others. (1 Mason, 66, 305; 3 Story. R., 133; 2 Woodbury and M., in Allen vs. Blunt.)

Undoubtedly much, which, in his first reflections on the matter, seemed to him novel, had been matter of deep enquiry and frequent experiments in the universities as well as private laboratories of Europe and even of America.

It appears, on examination, that as early as 1746, Winkler at Leipsic, had used common electricity for telegraphic communications by the discharge of Leyden jars in connection with a long wire. (3 Annals of Electricity, 445 p.)

In 1748, the same was done by Watson with two wires on an extended circuit of four miles. (Ditto, 445, and Barret's Ev. 208 a.)

And in 1784 or 1787, Leonard, by frictional electricity

and a wire extending into another room, transmitted telegraphic signals. (Vail's History, 121.)

In 1794, Reizer, by an electric spark and wires, illuminated letters of tin foil at a distance on a glass plate. And in 1798, Betancourt, in Spain, sent this spark by Leyden jars and a wire, twenty-six miles, and in the same year, Salva, at Madrid, worked for many miles what was called "an Electric Spark Telegraph." (3 An. of Elec. 446; Vail's His. 121.)

If nothing more had occurred than these cases, it would be a little surprising that any one, acquainted with the subject, should in 1832, near thirty-eight years after, anxiously inquire, as if a novelty and wonder, whether electricity could not be used for telegraphic communications.

But galvanism having been discovered in 1790, it is not strange, after the experiments with it for seventeen to nineteen years, that Soemering should, at Munich, 1807, be able to erect a galvanic telegraph, and make the voltaic pile decompose water, and show, as signals, air bubbles, over the proper letters, and conduct a wire to a trough, in which were thirty-five gold pins, with letters or numbers on each, and so arranged as to complete a communication of information, (3 An. of Elec. 448; Vail's His. 122; Hibbard Ev. 31. a., Gould 68 a.)

Common electricity had been found too intense and erratic, and difficult to be confined, whereas, that generated by galvanism had proved more quiet and manageable, and not costly.

Enquiries, therefore, did not stop here, but under that, were much multiplied and advanced, long before the year 1832.

In 1813, Oersted, the Danish philosopher, commenced his experiments on the subject, and by 1819 or 1820 discovered that a magnetic needle at a distance might be deflected by a

galvanic current, and thus mark information, and he is generally considered the discoverer of the magnetic properties of electric currents. (Ditto, Hibbard Ev. 29 a, Daniels Chem. 561–2; 3 Hewett on Inductive Science, 309.) In the interim of 1816, Doctor John Redmond Cox, of Philadelphia, described the use of galvanism for a telegraph by decomposing water, (Vail's His. 129, and Thompson An. of Ph. 162.) How its decomposition and the air bubbles enable the machine to act is fully explained by Channing Ev. 46 a.

In the same year Ronalds constructed a telegraph at Hammersmith, which operated for eight miles, and used the disc of clocks for his signals at both ends, keeping exact time, and one, when touched, indicating the same at the other end. But it worked very slow, the interval between each was so great. (3 An. of El. 349.)

In 1820, Arago, Ampere, and Sir Humphrey Davy, all experimented and discovered as much as Oersted had; and Ampere expressly stated, that the deflective needle would, in his opinion, be used for telegraphing by the magnetic fluid. (Vail's His. 133–4; Prof. Henry's Evid., 85 a, record; Doct. Channing's Ev., 17 a, record; Hibbard Ev., 31 a.)

The use of magnetism in connection with electricity to make communications by telegraphs, thus became known and practised to some extent, twelve years before Mr. Morse proposed to commence any improvements on the subject.

This last period was a new era in the science and in the mode of operating by deflecting the needle or lever by magnetism. The preceding era, from 1790 to 1820, had been distinguished by decomposing water, ringing a bell, exploding a pistol, and other great changes and improvements, introduced by galvanism, in a manner superior to common frictional electricity. All before that had been the circuit by wires, and the use, so far as practicable, of the spark and

other signals connected with it, through ordinary electric power. (Channing Ev. 41 a.)

It is not a little remarkable, looking to both Morse and House as inventors, that Ampere's plan was to have as many wires as letters, and press down a key on each as wanted. (Do. 36 Lon. Jour. 131.) And that the same year Cavallo proposed the communication to be made by a spark as a signal. (3 An. of Elec. 446.)

The public mind, among the scientific and machinists, had got so excited on the topic four years previous to 1832, the period of the voyage in the Sully, that numerous attempts were made in 1828 to carry out into more practical use, and to perfect what had been before indicated so often and so distinctly, as to the use of electricity and electro-magnetism for the purpose of telegraphing. Jacob Green wrote on it. Triboaillet proposed to act by a wire from Paris to Brussels, and Sturgeon actually constructed at Woolwich an apparatus with a horse-shoe magnet, and the end of a wire coiled round it, communicating with the opposite poles of a galvanic machine, and thus supporting a weight or bar of nine pounds. (19 Silliman's Jour. 330. Prof. Henry, 84, r.)

It is believed that Prof. Henry had discovered and described as early as this, and shown at Albany, in 1829, how to increase the power at little expense. (Do. 400; Professor Henry's Ev. 86, r.) And Feckner suggested that galvanism could thus be applied to telegraph from Leipsic to Dresden. (Vail's Hist. 135.)

But the most surprising discovery on this subject, about this period, was by Harrison Grey Dyer, another enterprising American. In 1827, or '28, he is proved by Cornwell, (64 a. r.) to have constructed a telegraph at Long Island, at the race course, by wires on poles, and using glass insulators. Doct. Bell (16 a. r.,) fortifies this statement,

having seen some of his wires, and understood its operation to be by a spark sent from one end to the other, which made a mark on paper, prepared by some chemical salts. (See also Channing Ev. 54, a; Chilton, Ev. 286, as to some such operations in 1828.)

Dyer's own deposition, taken since this cause was argued, and to be substituted for a letter from him to Doct. Bell, which was then objected to by the plaintiff and ruled out, now verifies the truth of the letter, and goes into several details as to the condition of his invention, when abandoned in 1830, from fears of prosecution by some of his agents.

He used common electricity and not electro-magnetism, and but one wire, which operated by a spark which, after going through paper chemically prepared so as to leave a red mark on it, passed into the ground, without a return circuit. The difference of time between the sparks was by an arbitrary alphabet, to signify different letters, and the paper was to be moved by the hand, while the telegraph operated, though machinery was contemplated to be introduced for that purpose. This device of an alphabet by spaces of time between sparks, evinced remarkable ingenuity, and differs in some degree from either Morse's or House's, though much nearer in principle to the former.

It seems that in 1830, Booth, in Dublin, explained fully how electro-magnetism could be used to telegraph at a distance, and *cause marks to be made by the fall of the armature* from the horse-shoe magnet when the circuit was broken. (Byrne's Ev. 199 r.)

But Barlow had failed of success in England from want of more power; and following out the new idea to increase the power of the magnet by closer coils of wire and otherwise, and when the want of greater power to operate further and quicker, and at less expense, seemed the chief desideratum,

Mull, in 1830, succeeded in making a magnet which would sustain seventy-five pounds, and soon after one hundred and fifty pounds; and Prof. Henry, in 1831, completed one that could sustain a ton.—(Hibbard Ev. 30 a 20, Prof. Sill. 201.) During this last year, also, Faraday had matured fully the horse-shoe magnet, and caused, under Saxton, at a distance, a strong circular motion, and brought magnetic electricity almost to maturity.

While all these clearly preceded what took place in the Sully, and remove very much all novelty in some of the ideas then suggested, yet it is certain that there yet remained to be constructed on these or other principles, some practical machine for practical popular and commercial use, which would communicate to a distance by electro-magnetism, and *record* quickly and cheaply what was thus communicated.*

From that time forward, Morse is entitled to the high credit of making attempts to do this, however imperfectly informed he may then have been of what had already been accomplished towards it; and he has the still higher credit, among the experimenters from that time to 1837, of having then succeeded in perfecting, what he describes at that time, in his caveat and specification. Laboring on the same subject, and before 1838, Sturgeon, in 1832, had formed a rotary "electro-magnetic machine," which gave motion to working models of machinery, so as to pump water, saw wood and draw weights. He had batteries of zinc and electro-currents from them, and magnets with attraction and repulsion. (3 An. of Elect. 433; 1 do. 75.) And Baron de Schilling, the same year or the next, constructed an electric telegraph, at St. Petersburg, which had thirty-six magnetic needles, and

*** It must not be supposed that tracing or marking was essential to the transmission of intelligence by electricity. Marking or recording telegraphs, which merely record dots and dashes, are not generally treated in Europe as any improvement, even on the needle telegraphs.—See ante p. 13 to 15.**

sounded alarms, and made signals by the deflection of the needle, which indicated letters by numbers.—(Vail's Hist. 155; Hibbard's Ev. 31; Channing Ev. 41.) In 1833, Dr. Soulther, at Zurich, caused a pendulum motion between two horse shoe magnets. (3 An. of Elec. 443), and Ritchie, with various others, showed how increased power could be cheaply created and used at a distance. (Barret's Evi. 214.) And Professor Henry made experiments for this object, with success, and explained that the fall of the weight or armature would ring bells, &c. (19 Sill. Jour. 329; 3 An. of Elec. 430.) Gauss & Weber constructed the first magnetic telegraph at Gottingen the same year, carrying the wires above ground and over houses, and making signs for letters. (Vail's History, 158; 3 An. Elec. 449; Hibbard's Ev. 31 a.) Some of their wires are still standing. (Gould's Ev. 67–9.)*

* The following is extracted from the evidence (Record, p. 215), from which it appears that as early as 1834, Gauss & Weber's invention of a process of recording marks on paper, moved by clock-work, was published:

Gauss' Electro-Magnetic Telegraph, 1833.—"A circuit of wire 7,460 feet long, was led across the houses and steeples at Gottingen, from the Observatory to the Cabinet of Natural Philosophy, requiring no especial insulation, which was a fact of great importance.

"The principle was thereby at once established, of bringing the Galvanic Telegraph to the most convenient form. * * * All that was required, in addition to this, was to render the signs audible; a task that apparently presented no very great difficulty,—inasmuch as in the very scheme itself, a mechanical motion, namely, the deflection of a magnetic bar, was given.

"Should it be desired that the indicator should write, it is merely required to adapt, to one end of the magnetic bar, a small vessel filled with a black color, and terminating in a capillary tube. This tube, instead of striking a bell, thus makes a black spot, upon some flat surface held in front of it. If these spots are to compose writing, the surface upon which they are printed must be kept moving in front of the indicator, with a uniform velocity; and as this is easily brought about, by means of *an endless strip of paper, which is rolled off one cylinder on to another, by clock-work*." (Annals of Electricity, vol. 3, 448, No. 17, March, 1839, copied from the *Gottingen Gelehrte Anzeigin*, p. 1272, 1834.)

And in 1834, Jacobi made one similar in some respects. (1 An. Elec. 410; (3 An. Elec. 434.) And Mr. Gurly, at Dublin, made another; and in 1836, Taquin & Eutychausen carried another over the streets of Vienna. (Vail's Hist. 159.) All which remained to complete what was desirable in a *tracing or writing* telegraph at a distance, was to make dots or marks—intelligible or significant of letters and words—so as to be read or translated with ease, and to perform the operation with useful speed.

To make dots and color them by the paper being chemical had already been discovered, but not an alphabet in connection, unless by Dyer, in 1828; (3 An. of Elec. 450;) nor a movement of the paper on a roller, so as to make the dots and marks successive, unless by him with the hand. The struggle was such, in 1837, to finish what was wanted, that Morse became alarmed lest others might first complete and obtain patents for the invention, and hence proceeded more actively with his, and in 1837 filed his caveat, in the month of October.* (Gale's Ev. 123.) In the same year, whether

* As to what Morse really did before the general movement in 1837, see ante pages 35 to 73.

Prof. Henry, in his deposition in the House case, (Record, p. 92,) relates a conversation between himself, Mr. Morse and Dr. Gale, in which the latter stated, "that Mr. Morse, previous to his (Dr. Gale's) connection with him, *had not succeeded in producing effects at a distance*; that when he was first called in, he found Mr. Morse attempting to make an electro-magnet act through a circuit of *a few yards of copper wire* suspended around the room in the University of New York, and that *he could not succeed in producing the desired effect even in this short circuit*; that he, Dr. Gale, asked him if he had studied Prof. Henry's paper on the subject, and that the answer was "No;" that he then informed Mr. Morse "that he would find the principles necessary to success explained in that paper." Dr Gale procured the apparatus, and, with these, the action was produced through a circuit of half a mile. (This appears to have been some

earlier or later is not known, Alexander formed an electric telegraph, by which, through signals somewhat like House's, he communicated, and spelt out at a distance, the word Victoria. (Vail's Hist. 185) See evidence that this was done earlier, using a key board, and letters on each key, like House's. (Evidence 83 a.) Davenport, too, in Vermont, announced another, and obtained a patent. in 1838. (3 An. of Elec. 535.) And Cooke, Wheatstone, and Steinheil, some using the needle, deflected; some making dots and lines; and some using the ground and water for a part of the circuit. (See same articles in Vail and the Annals before cited.) Cooke and Wheatstone took out a patent for theirs in June, 1837, making the deflection of the needle point to letters on a board.) (Hibbard Ev. 31.)

Steinheil that year had, at the Royal Observatory, an electro-magnetic telegraph, half a mile long, on poles. (Vail, 179.) This made dots and short marks on paper, and preceded Morse's caveat according to Dr. Channing's evidence 48, a, rec., and Hibbard, Ev. 27, a., 31–2, (being before July 19, 1837,) Gould, Ev. from 7 a, 8 a.

It used the ground as a part of the circuit which had been before discovered, but which Morse does not appear to describe or claim, till his first renewal in 1848. (Dr. Channing, Ev. 54, a.)

Nor did Morse use poles or posts at first, in 1844, when constructing a telegraph between Baltimore and Washington. (Avery's Ev. 125, rec.) Though they were used by Steinheil before 1839, and by Dyer, even in 1828,—(Cornwell, Ev. 64, a,—Channing, Ev. 49, a.;) and were suggested to Morse early as 1838 by Prof. Henry, 89, r., *yet Morse thinks he himself*

time in the year 1837.) Prof. Henry, in 1830, showed, in public, how mechanical effects could be produced at a distance, both in the deflection of a needle and in the action of an electro-magnet.—(Ib.)

invented them, (59 r.) After all this, there still was wanting a more perfect succession of marks to be made or recorded, which were letters themselves, or signs of letters, intelligible by an alphabet and power obtained and applied so as to do it quick enough for purposes of business, (Chilton, Ev. 286; Gale's Ev. 124; Renwick's Ev. 234–5.) This deficiency was at length supplied.

Among about sixty-two competitors to the discovery of the electric telegraph by 1838 (as computed in Channing's Ev., 41, a,) Morse alone, in 1837, seems to have reached the most perfect result desirable for public and practical use. (R. 6, Morse's Ev., 128–9, r.) This may not have been accomplished so wholly by the invention of much that was entirely new as by "improvements," to use the language of his patent, on what had already been done on the same subject, improvements, ingenious, useful and valuable. By the needle or lever instead, not only deflected by the magnet, but provided with a pen to write, or, in other words, a pin at the end to make a dot or stroke, when thus deflected as the circuit was held longer closed or broken, with machinery to keep the paper moving in the meantime, and so as to inscribe the dots and lines separately, and more especially with an alphabet, invented and matured, assigning letters and figures to these dots and lines according to their number and combination, he accomplished the great desideratum. (1 Renwick's Ev., 235.) Thus the fortunate idea was at last formed and announced, which enabled the dead machine to move and speak intelligibly at any distance, with lightning speed.

It will be seen, that amidst all these efforts at telegraphic communication by electricity and electro-magnetism, more or less successful from 1745 to 1838, none had attained fully to what Morse accomplished.

Some had succeeded in sending information by signals,

even beyond the decomposition of water and the deflection of the needle. They had made persons at a distance recognize the sign used, and thus obtain intelligence. They had also made marks at a distance. But in no way does it appear that they had sent information at a distance, and at the same moment, by the same machine, *traced down and recorded* it permanently, and intelligibly, and quickly. This triumph was reserved to Morse's inflexible perseverance in experiments and close observation; and chiefly after arming the end of the needle or lever with a pin, by use of a roller, with appropriate machinery to move his paper, so as to trace successive dots and marks, and by a stenographic alphabet to explain the marks made on the paper, and by more power through his combined circuits, to effect all at a greater distance, and with greater dispatch. (Gales' Ev. 123 r.) Afterwards, by the improvements in batteries made by Daniel and Grove, he was enabled, in 1843, without these local circuits, to increase the power of the electro-magnet so as to accomplish this at any distance, and with a speed and economy which rendered the invention applicable to general use. (Jackson's Ev., 166.) Before 1843, Hare's battery was used, and was too feeble, (Jackson's Ev., 164 r, Channing's 45 a,) and before that Cruikshank's. The want of this increased power had rendered former attempts at times abortive for practical purposes; and its being recently supplied by the science of Faraday and Henry—tended, more speedily (by Daniel and Grove's battery, founded on them) to remove the greatest obstacle to success. (Davis's Manual, p. 125; Silliman's Ev. 95 a, Jackson's 166).

Others had before, and about the same time as has been noticed already, made marks on paper at a distance by the deflection of the needle, and by sparks, and attached special meanings to them, and the spaces between them. But the

evidence is strong that Morse's, *if not the very first*, in these respects was *the most perfect and available for practical use*,* and the improvements by others in batteries came very opportunely to aid in its power for distant operations, beyond what even the local circuits had done. (Prof. Silliman Ev., 95 a.) His special advance beyond others, except some new combination, looks as if *chiefly mechanical*, but still it sufficed to promote the desired object.

By them and his new combinations he was going a step further than any of his predecessors for practical use had accomplished, and this entitles him to protection and the fame he has achieved. This he and his assignees can therefore protect, but not particulars known long before him, or which he neither claimed, nor described, nor invented. As before explained, he must not be considered to have claimed the invention of the general principle or art of telegraphing by electro-magnetism, nor could he, as already shown, have protected it if he had. But all he clearly claimed was "a method" of doing it—"an improvement" in doing it—and these he has a right to protect, and these only. They were a pin to mark or trace in the end of his lever or needle, a happy thought, but the movement of the paper on a roller was almost as necessary to receive marks in succession—and his alphabet to be thus applied and used was the crowning act of his invention. (Renwick, Ev. 245, r.)

Much more might be offered as to the details of Morse's machinery, and as to those inventions existing before and since—and how far the latter have been imitative or independent. But it is not necessary to explain or discuss them for the purpose of settling the present case.

* There is, even at this day, a difference of opinion amongst Telegraphers as to the respective merits of the pointing, dotting, magnetic and chemical telegraphs. See ante pp. 13, 44, 53.

It is certain, that in 1837, he had so far completed his invention as to announce it in his caveat, and have it described also, by a brother, in a public paper called the *Observer*,* and in Silliman's *Journal*. And that though a specification followed in '38, and a patent in '40, without putting it in operation for practical purposes, yet, by the aid of Congress in '44 it was successfully used from Baltimore to Washington. It thus became perfected and turned to practical account; and is to be protected to its legitimate extent against every real violation."

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* See the publication, ante page 47. It appeared in the *New York Observer*, April 15th, 1837, and was a mere general statement that a gentleman of the editor's acquaintance (meaning his brother, Mr. S. F. B. Morse, then living in the same city) had invented an electric telegraph of some kind or other, whether electro-magnetic, chemical or otherwise is not stated, but there were to be 24 wires, each representing a letter of the alphabet. The wires necessary for a distance of a hundred miles were not to weigh many pounds, and were to be inclosed in an India rubber tube and supported on poles. This was not a description of a completed invention.

The Electric Telegraph, its History and Progress, by Edward Highton, C. E.

After a few remarks on telegraphs, by means of light and by direct sight, Mr. Highton proceeds with the history of telegraphs by electricity. He avails himself of a great number of publications which have appeared within the last half century, especially in the English, French and German languages, on the subject of the electric telegraph.

TELEGRAPHS BY ELECTRICITY.

It is now scarcely a century since electricity was first proposed to be employed for the purpose of communicating intelligence between distant places.

Many and various were the discoveries and inventions that were required before the electric telegraph could be made to assume its present state.

It is not to one person alone that the world is indebted for this wonderful invention. Hundreds of eminent persons have labored in the field, and numerous men of science have from time to time added their quota both of discovery and invention.

It was not for many years after the *first form* of electric telegraph was devised that sending telegraphic intelligence, by means of electricity, to any considerable distance, could be regarded as either physically or commercially practicable.

Even at this day the electric telegraph may be considered as only in its infancy. Every year improvements are being made, and fresh discoveries come to light. (p. 6.)

ON THE PRODUCTION OF ELECTRICITY.

Electricity may be produced in a variety of ways: by friction; by chemical action; by magnetic induction; by change of temperature; by the power and at the will of certain animals. The three first modes are those usually employed in the electric telegraph. (p. 8.)

ELECTRICITY FROM FRICTION.

The discovery of frictional electricity is of very ancient date.

Thales of Miletus, who lived about 600 years before the Christian era, is reported by subsequent writers to have described the power developed in amber by friction, by which the amber was enabled to attract to it pieces of straw and other light substances. (p. 8.)

It does not appear that any of the ancients reasoned upon those observed effects; they merely observed, and recorded them as facts.

Dr. Gilbert, however, at the commencement of the sixteenth century, instituted a series of experiments upon the subject. He found that the property possessed by amber was not confined to that substance alone, but belonged to several other bodies, such, for instance, as the diamond and many other precious stones, glass, sulphur, sealing-wax, rosin, &c.

Boyle found that warming these bodies increased the effect.

To Otto Guericke, of Magdeburg, who was also the inventor of the air-pump, is due the invention of what is commonly called the Electrical Machine. This philosopher mounted a globe of sulphur upon an axis, and, on turning the globe round, applied friction to it. By this means he detected that strong electrical excitation was accompanied both by light and

sound: he also discovered that after a body had been electrically excited, and another light body brought in contact with it, a repulsion ensued. Many other of the now well-known phenomena of attraction and repulsion were demonstrated and recorded by this philosopher.

In 1675, Sir Isaac Newton made several important discoveries relating to the above, and noted down the effects observed in his experiments on the subject.

Hawkesbee, between 1705 and 1711, made various discoveries. He substituted a globe of glass in lieu of the globe of sulphur of Otto Guericke, and fixing it in a wooden frame, he produced an electrical machine very similar to those now in general use.

Grey and Wheeler experimented further, and succeeded in producing motion in light bodies at distances of 666 feet.

M. Du Fay, between 1733 and 1737, conducted a series of important experiments, and greatly enlarged the number of phenomena observable in bodies when acted on by electricity in this state.

The Abbé Nollet, on witnessing some experiments, discovered a simple principle that accounted for the apparently anomalous results obtained by former experimenters, and explained satisfactorily the cause of a body being first attracted and then immediately repelled after contact.

Amongst those who about this time labored in the science may be mentioned with distinction the names of Desaguliers of France, Boze of Wittemburg, Winkler of Leipzic, Ludolf of Berlin, and Dr. Miles; each of whom brought fresh facts to light, or improved upon the apparatus then in use.

Dr. Watson, in 1745 *et seq.*, conducted several important experiments, which are duly recorded in the "Philosophical Transactions."

Kleist and Muschenbroeck, at Leyden, simultaneously dis-

covered a means of accumulating the electric power by the invention and employment of the Leyden jar, although the honour of this discovery is by some attributed to a person named Cuneus.

Dr. Bevis recommended the coating of the outside of the jar with tinfoil, water having been previously used by Muschenbroek and Kleist in the interior of the jar.

Dr. Watson, however, applied the tinfoil both to the inside as well as to the outside of the jar, and thus perfected the Leyden jar. In this state it now remains.

The distance to which the electric power might be conveyed next occupied the attention of philosophers both in England and France. Experiments were made in the Tuileries on the subject, and electricity transmitted through a circuit of considerable length.

Dr. Watson, in 1747, in the presence of many scientific persons, transmitted the power through 2800 feet of wire and 8000 feet of water, thus employing in his experiments the use of the *earth circuit.*

Afterwards, on the 14th of August, 1747, Dr. Watson conducted an experiment on a much larger scale at Shooter's Hill. The wire was insulated by baked wood, and was 10,600 feet or nearly 2 miles long. (p. 9 to 11.)

From this period until the invention of the Hydro-Electric Machine little progress was made in the art of producing electricity by friction.

In 1840, at Newcastle on Tyne, it was observed that a jet of steam issuing from the boiler of a steam-engine emitted electricity in considerable quantities, and that on applying a conductor to the jet, powerful sparks were obtained.

Mr. Armstrong, of Newcastle, made many experiments on this newly discovered source of electricity, and ultimately constructed what is now called the Hydro-Electric Machine. (p. 11.)

ELECTRICITY FROM CHEMICAL ACTION.

After the Leyden jar and the electric battery, composed of a number of such jars, had been experimented on in various ways, and by means of the power so accumulated metals had been fused, volatilized, reduced to dust, or dispersed in air, the lives of animals and vegetables taken away, and other striking effects produced on matter, for a long period little or no further progress was made.

At length Galvani, in 1791, stumbled as it were by chance upon what was then thought a new fact in the science. This ultimately led to most important consequences. Through it, means were obtained of producing enormous quantities of electricity, and that from the chemical action of bodies on each other.

It appears that Du Verney had made the very same observations as Galvani had done about a century before, without the circumstance having attracted the attention of philosophers at the time.

The reader will probably be too well acquainted with the story of Galvani and the frogs to need a repetition of the circumstance. Suffice it to say, that the accidental contraction of the muscles of a frog, when in the proximity of an electrical machine, led to some of the most brilliant discoveries that have ever adorned the annals of science.

Various hypotheses were framed to account for the peculiarities observed in the experiments with the muscles of animals.

Valli wrote on the subject, and in 1793 Dr. Fowler published his essay on *Animal Electricity.* The same subject was also investigated by Dr. Robison.

Professor Volta, of Pavia, confuted many of the theories adduced, and ultimately produced the arrangement known as

the Voltaic Pile, the first rude form of what is now termed the Galvanic Battery. A letter of Volta on the subject was published in the "Philosophical Transactions" for 1793.

During the heat of the discussions between the partisans of the theories of Galvani and Volta, Fabroni repeated many of the experiments, and communicated his researches to the Florentine Academy.

It is in this paper that the first suggestion as to the *chemical origin* of galvanic electricity is to be found.

On the 20th of March, 1800, Volta addressed a letter to Sir Joseph Banks, then President of the Royal Society, in which he announced to him the discovery of the VOLTAIC PILE.

After due investigation of this instrument, Volta endeavored to improve the arrangement of its parts, in order to obtain a greater amount of power. The result was the invention of the apparatus known by the name of *La Couronne des Tasses.* This arrangement consisted of a circle of cups, each cup being filled with warm water or with a solution of sea-salt, and having also a piece of silver and a piece of zinc in the liquid.

The pieces of the two different metals in the same cup were not in metallic contact, but the zinc of the *one* cup was metallically united to the silver of the *adjacent one*, and so on throughout the series, the liquid alone intervening between the metals in the *same* cup. Thus it is evident that in this arrangement of the *couronne des tasses* we have a complete and perfect galvanic battery. We have the insulated cell, and the two metals in the cell separated by a liquid capable of acting chemically upon one of them.

Many important improvements have, however, been made in the materials employed, though the *principle* of the battery remains now as it left the hands of Volta. (p. 12, 13.)

Many experiments were made by Valli, Fowler, Robison, Dr. Wells, Humboldt, Fabroni, Nicholson, Carlisle, Cruikshank, Haldane, Henry, Davy, Wollaston, Trommsdorff, Van Marum, Pfaff, Aldini, Hisinger, Berzelius, De Luc, De la Rive, Becquerel, and others; and new facts were added yearly to the existing stock of knowledge. Several kinds of acids were used; charcoal was substituted for one or both of the metallic plates; wires were made red-hot, and various substances difficult of decomposition easily decomposed by the electric action.

Other powerful forms of galvanic batteries were afterwards contrived, both by Professor Daniell and Professor Grove—forms and arrangements which admit of a uniform and continuous flow of the electric power for a considerable period of time.

Daniell's constant battery, as it is called, consists in having two liquids in each cell, the liquids being separated by a porous diaphragm—the one liquid being dilute sulphuric acid, and the other a saturated solution of sulphate of copper: in the latter, copper plates are immersed, and in the former, plates of zinc.

Grove's battery consists of two liquids and two metals—the liquids being nitric acid and dilute sulphuric acid, and the metals platinum and amalgamated zinc: the plates of platinum are immersed in the nitric acid, and the zinc in the dilute sulphuric acid.

An important discovery, in order to prevent the local action of the diluted sulphuric acid on zinc, was made by Mr. Sturgeon and Mr. Kemp. This consisted in rubbing mercury over the surface of the zinc. By this means the other forms of galvanic batteries are made to last a much longer time, and the flow of electricity during the action of the battery becomes far more constant and regular.

The relation which the galvanic battery bears to the Leyden jar or the common electrical machine may be thus stated:

In the Leyden jar, a sudden, instantaneous, and violent effect is produced on any body through which the power passes: a torrent of force precipitates itself, as it were, instantly along the line of communication, while in the galvanic battery the power flows in a gentle and continuous stream, producing a constant and uniform action for any definite period of time.

From the Leyden jar, the whole force passes in an inconceivably short space of time, while from the galvanic battery the action may be continued as long as desired.

Just as in mechanics a sudden blow from a hammer differs from a continued pressure, so does the action of electricity from the Leyden jar differ from that produced from the galvanic cell.

During the last few years improvements have been made in batteries, and especially with regard to the peculiar requirements of the electric telegraph. (p. 14, 15.)

Mr. Highton describes some of these improvements, and then traces the history of the production of electricity from the magnet, and by various other means.

THE MEANS EMPLOYED FOR MAKING THE PRESENCE OF THE ELECTRIC POWER COGNIZABLE TO THE SENSES.

No sooner had the sulphur ball of Guericke, the glass globe of Hawkesbee, and the glass cylinder of Gordon, been used, than ready means were furnished of trying experiments on an extended scale; and when the Leyden jar was invented, the apparatus for research became almost perfect.

The very first notice that we have of the effects produced by electricity consists in its power of attracting light substances, as bits of straw, &c. Such effects are said to have

been described by Thales, some 600 years before the Christain era.

To Dr. Gilbert, however (A. D. 1600), is due great credit for the multiplicity of his experiments on this head.

In order to test the effects of the various bodies, Dr. Gilbert brought them to the end of a light needle of any metal, balanced and turning freely on a pivot, like a magnetic needle.

Otto Guericke clearly demonstrated that a light body, after it had by attraction been brought into contact with an excited electric, was repelled by it. He also found that if light bodies were suspended within the sphere of action of an excited electric, they themselves became possessed of electrical excitation.

Now this property is one which was employed in one of the first electric telegraphs at work in this kingdom, viz., in Ronalds's: in this telegraph two pith-balls were made to diverge by electricity when desired, and thus to denote the signals desired.

It should be remarked, that up to the year 1720, attraction and repulsion were considered as the only absolute proofs of the presence of electricity, although it had also long been observed that light was produced by electrical excitation.

For some time the minds of philosophers seemed to have been devoted to the production of as powerful an electric spark as possible. Thus we have Boze, Winkler, Gordon, and Ludolf of Berlin, all laboring with this end in view,—the principal object appearing to be to set inflammable substances on fire thereby.

Ludolf of Berlin was the first to accomplish this; he succeeded in setting on fire a highly inflammable spirit.

The noise made by this firing of a spirit was employed in 1816 in Ronalds's electric telegraph, for the purpose of

calling attention previously to the communication of intelligence.

The passage of the electric spark was used by Reizen, in 1794, as the means of designating any of the letters of the alphabet. (p. 24, 25.)

We will now pass on to the means used when galvanic electricity was employed for rendering its presence discernible by the senses. (p. 26.)

Œrsted, in 1819, discovered that a magnetic needle delicately suspended in proximity to a conductor through which an electric current was passing had a tendency to place itself at right angles to such a conductor. The application of this principle to the electric telegraph has been almost universally adopted in this kingdom, and most extensively employed in other parts of the world.

To Ampère is due the discovery that a wire through which a galvanic current is passing may be made to assume all the properties of the magnet itself. This induced magnetic power was found to cease the instant that the current was arrested.

M. Arago also, at the same time, published the fact that iron filings were attracted by such galvanic wire, and that the wire had thereby the power given to it of producing temporarily, in iron, magnetic properties that did not previously exist in it. In this way M. Arago showed that the wire had the effect of *permanently* magnetizing a needle of steel.

Many of these experiments were conducted jointly by MM. Arago and Ampère. These philosophers investigated the action of coils and helices of wire, and at length demonstrated that a helix of wire, with a current of electricity passing through it, may be made to produce all the effects of the magnet itself.

Sir Humphry Davy at this time commenced a long series

of experiments, which have proved of the greatest value to the science. Very few new facts, however, seem to have been brought to light by him which have special reference to the effects produced by the electric currents in order *to mark its presence* on its passing through a conductor, and to make the same cognizable to the senses.

In 1821, Faraday commenced a series of most important experiments. With the advantages he possessed in having at his command a most extended and powerful apparatus, he produced results highly beneficial to the advancement of the science.

The great discoveries of Faraday, at this date, were confined principally to the relative directions and powers of the electric and the induced magnetic forces.

About this period many German philosophers and others repeated and extended the experiments of Œrsted and Ampère,—amongst whom may be enumerated the names of M. le Chev. Yelin, M. Brockman, M. Van Beek, M. De la Rive, M. Moll, Mr. Barlow, Mr. Cumming, and others.

Mr. Cumming, in April, 1821, appears to have been the first to notice the *increased effects* of a convolution of wire around the magnetic needle, and thus to produce the arrangement known as the galvanometer. This arrangement was subsequently adopted by Professor Wheatstone in his first electric telegraph. The discovery of one of the most important parts, however, of the electric telegraph remains yet to be described.

To the late Mr. Sturgeon is due the discovery of the *electro-magnet.* Mr. Sturgeon was the first to discover that if a bar of *soft iron* be surrounded with coils of wire, and an electric current be transmitted in the same direction through each convolution, that the soft iron bar instantly becomes a magnet, and is capable of attracting other pieces of soft iron

or steel, and that it remains magnetic so long as the electric current is passing through the coils; and that as soon as the current ceases, the bar instantly loses its magnetic condition, and no longer attracts pieces of adjacent iron or steel.

This property of iron becoming magnetic under the above conditions has entered more or less into almost every form of electric telegraph since the above period, and is one of its most valuable component parts.

Another, and perhaps not less important effect produced by the electric current, as applicable to telegraphic purposes, is the *decomposition* of water and other similarly constituted substances when a current of electricity is made to pass through them. (p. 26 to 28.)

The peculiarity possessed by the electric current, of changing, by decomposition, the color of bodies submitted to its action, has been variously employed in the electric telegraph in recording the transmission of electric currents, and has now become one of the means of carrying on a correspondence by means of electricity. (p. 29.)

Sir Humphry Davy also greatly extended by his valuable researches our knowledge of and insight into this remarkable peculiarity of the action of electricity.

Dr. Desaguiliers devoted considerable attention, from the time of the labors of Grey until the year 1742, to the means for transmitting electricity to a distant place. He was the first who applied the term *conductors* to bodies through which electricity passed with comparative freedom. He showed also that the conducting power of animal substances was due to the fluids that they contained.

Dr. Watson also proved, experimentally, that a shock could be passed with great facility through a great number of men at the same instant of time.

The attention of philosophers was now directed to ascertain to *what distance* the shock could be transmitted.

At Paris, M. Nollet transmitted a shock through 180 soldiers. He also formed a chain measuring 5400 feet by means of iron wires extending between every two persons: the whole company received the shock at the same time.

A discharge from the Leyden jar was also effected through circuits of 900 and 2000 toises in length, and in one experiment the basin of water in the Tuileries formed part of the circuit. It was in England, however, that experiments on this subject were made on a more extended scale. (p. 31, 32.)

Dr. Watson, in 1747, stretched a wire across the Thames over Westminster Bridge. (See ante page 24.)

The next experiment was made by Dr. Watson, at Stoke Newington, near London, where a circuit of nearly two miles was used. This circuit, as in the former case, was made up partly of wire and partly of the earth, the wire being in one case 2800 feet long, and an equal distance intervening through the earth. It was found, too, that the effect was the same whether the rod was only dipped into water or driven into the earth.

Similar experiments were tried at Highbury, in 1744, and finally at Shooters' Hill, in August, 1747. In the experiments at Shooters' Hill, the wire was 10,500 feet long, the observers being thus separated by a distance of two miles. The wires were supported on *posts* of wood. The whole circuit was therefore four miles long, being composed of two miles of wire and two miles of earth.

It now became a well known fact that electricity COULD be transmitted over a very considerable distance by means of an insulated wire, and that the effects produced in every part of the circuit were, if not absolutely instantaneous, yet practically so to all intents and purposes. No more experiments were therefore needed to confirm these simple facts. It was absolutely necessary, however, for these facts to be proved, before an electric telegraph could be treated as practically possible.

In 1837, Dr. Steinheil used no less than 7 miles of wire for his telegraph at Munich.

In 1839, Dr. O'Shaughnessy conducted an extensive series of experiments in India, with the view to ascertain the most suitable form of electric telegraph for that country. To Drs. Steinheil and O'Shaughnessy is due the carrying out of Dr. Watson's method, now so generally adopted in Great Britain and America, viz.: of suspending the telegraphic wires in the air from post to post. Dr. O'Shaughnessy erected for his telegraphs no less than 22 miles of wire: the wires were of iron. They were fastened to poles of bamboo, 15 feet out of the ground, and were made to hang at distances from each other of about twelve inches. Dr. Steinheil had also 7 miles of wire, which was partly of copper and partly of iron. In Dr. Steinheil's telegraph the wires were four feet one inch apart.

These important experiments of Dr. Watson, Dr. O'Shaughnessy and Dr. Steinheil set the matter completely at rest, and rendered the idea of communicating intelligence between distant points, by means of electricity, no longer chimerical or doubtful, but a matter of absolute certainty.

The various discoveries enumerated above furnish therefore all the materials necessary for the formation of an electric telegraph. *Each inventor has, since such period, turned to this common stock of knowledge for the materials wherewith to build up his particular arrangements of telegraphic apparatus.* One inventor has employed electricity produced by friction, another galvanic electricity, and a third magneto-electricity, and so on; and then each has used the apparatus most suited for the employment of the electricity so generated.

Having thus briefly noticed the discovery of the various component parts of an electric telegraph, it is proposed to

proceed now to deal with the electric telegraph as a whole and to notice as concisely as possible the particular arrange. ments recommended by various persons for the construction of a complete electric telegraph. (p. 32 to 34.)

TELEGRAPHS INVENTED PRIOR TO ANY OF THOSE WHICH HAVE BEEN PATENTED.

It has been thought well, before describing the plans of telegraph which have from 1837 to the present time formed the subject of patents in this kingdom, to notice briefly the principal features of the many telegraphs which preceded those for which patents were granted.

All these first telegraphs were freely given to the world by their respective inventors, and have furnished the materials employed by late patentees for their telegraphs.

It is clearly very difficult, now that so many years have elapsed since these first telegraphs were invented, to fix the *precise* date at which the inventions were publicly known in *this* and *other* kingdoms.

The invention of the electric telegraph has, in different countries, been attributed to different individuals. Nothing, however, can be more incorrect than to attribute to any *one* man the invention of the electric telegraph, as so many eminent men have lent a helping hand in adapting the wonderful discoveries in electricity to the purpose of conveying intelligence. If to any single person the honor of having "invented the electric telegraph" is to be attributed, it surely ought to be either to the first person who proposed the employment of electricity for telegraphic purposes, or to the first person who did practically convey intelligence to a distant point by means of electricity. If so, then no *patentee* can claim the honor of inventing *The Electric Telegraph.* (p. 37, 38.)

Mr. Highton describes the various telegraphs invented prior to the grant of the first patent. The following are extracts from his remarks on the more modern telegraphs :

COXE'S TELEGRAPH.

In Thompson's 'Annals of Electricity,' in 1810, Professor Coxe, of Philadalphia, alludes to certain plans of telegraphing by means of the galvanic pile. He appears to have had two plans—the one being by the decomposition of water at distant stations, and the other by the decomposition of metallic salts.

Thus we see that as each successive discovery in the *effects* produced by electricity became known, ingenious men in all parts of the world turned their attention almost immediately to the application of those very discoveries to the art of telegraphing. (p. 49.)

RONALDS'S TELEGRAPH.

In 1816 and the following years Mr. Ronalds, of Hammersmith, devoted much time to the investigation of the electric telegraph. He erected eight miles of insulated wire on his lawn : he also buried a considerable length of insulated wire in the earth. (p. 49.)

Mr. Ronalds, in 1823, published a full description of this telegraph, in a work entitled 'DESCRIPTIONS OF AN ELECTRICAL TELEGRAPH, AND OF SOME OTHER ELECTRICAL APPARATUS.' (p. 51.)

Mr. Ronalds enters on the subject of the comparative merits of wires suspended in the air and wires buried in the earth, and arrives at the conclusion that subterranean wires are much to be preferred, although many persons were found to object to that plan.* (p. 52.)

* Subterranean lines have very recently been laid down in England and in Prussia. The wires are insulated by gutta percha, and the whole is usually inserted in a lead pipe.

In 1823, Mr. Ronalds wrote to the Lords of the Admiralty, requesting an inspection of his electric telegraph. He strongly recommended its adoption for Government purposes.

The result of this communication will be best learnt by an extract from a work published by Mr. Ronalds in 1823.

Mr. Ronalds in a note says: "Lord Melville was obliging enough, in reply to my application to him, to request Mr. Hay *to see me on the subject of my discovery*; but before the nature of it had been known, except to the late Lord Henniker, Dr. Rees, Mr. Brande, and a few friends, I received an intimation from Mr. Barrow, to the effect '*that telegraphs of any kind were then wholly unnecessary, and that no other than the one then in use would be adopted.*" (p. 5.)

AMPERE'S TELEGRAPH.

Immediately after the brilliant discovery of Œrsted in 1819, (viz. that a magnetic needle always tends to place itself at right angles to an adjoining wire through which an electric current from a galvanic battery is passing,) Ampère read a paper before the Academy of Sciences, at Paris, in 1820, on a plan for an electric telegraph, based upon this discovery of Œrsted. Its *principle of action* was the one subsequently used by Professor Wheatstone in all his needle telegraphs, and therefore to Ampère, who first proposed the use and combination of the magnetic needle—the coil of wire—and the galvanic battery, is due the credit of being the first person to publish to the world the perfect practicability of an electric telegraph constructed *with magnetic needles surrounded by coils of wire*, and moved by electricity generated in the galvanic battery. Ampère proposed to use as many needles as there were letters or symbols required to be denoted. Wheat-

stone, by combining the apparatus of Ampère in a peculiar way, obtained twenty letters by the use of only five wires, as will be explained hereafter, and, therefore, greatly improved upon Ampère's plan.

The plan of Ampère was as follows: He proposed to have at every station from which intelligence was to be sent, a galvanic battery, with all necessary keys for putting the battery in communication with the wires, and to have at the points where intelligence was to be received as many magnetic needles as there were letters required to be denoted. Each letter was placed upon a different needle, and the needles were surrounded with coils of wire in metallic communication with the wires extending between the stations. It is evident, therefore, that upon the transmission of a current of electricity through any one of those coils the needle would move, and with it the letter, and thus letter after letter would be denoted.

Here, then, we have the first good needle telegraph, and one all but perfect in its parts, with the exception only of the *great number of wires* required to be employed.

Ampère, it is true, might not have given all the minor details as to the keys, &c., nor was it in any way needed at the time, inasmuch as any one who had ever used a battery and tried experiments therewith, would at once have known how to make suitable keys in a dozen different ways, and how to convert a receiving station into a transmitting station whenever required to do so. Much misapprehension on this point seems to have prevailed of late in the minds of certain scientific men in this kingdom; but the circumstances under which those opinions have been expressed are so peculiar, that every allowance must be made for the parties.

So well understood does the magnetic needle telegraph seem to have been in 1827, that Dr. Green, who wrote at that

time, says—"In the very early stage of electro-magnetic experiment it had been suggested that an instantaneous telegraph might be constructed by means of conjunctive wires and magnetic needles. The details of this contrivance are so obvious, and the principles on which it is founded are so well understood, that *there was only one question which could render the result doubtful. This was, whether, by lengthening the conjunctive wires, there would be any diminution in the electrical effect upon the needle.*"

It was evident, therefore, at this time that nothing was wanting but direct experiment to test this, then doubtful, point, as to how far galvanic electricity would travel through a wire. Professor Barlow's opinion was, that the force of the current would be so diminished by the length of the circuit that a galvano-electric telegraph would, for long distances, be impracticable. Other scientific men differed from Professor Barlow in this opinion. To Professor Wheatstone is due the credit of having *practically* solved the question, in ascertaining the relative resistances of the parts of the circuit of an electric telegraph, and also of adjusting the size and length of wire required for the magnets to be employed. Professor Ohm founded the mathematical expression for the law of the resistances to the passage of ALL electric currents from the galvanic battery. These resistances were expressed not only in terms of the line-wire, but in terms of the size and distance of the battery-plates from each other, and also of the resistance of the fluid in the battery itself. Professor Wheatstone, therefore, had only to apply this general law to the peculiarities of the electric telegraph, and the problem would become at once satisfactorily solved, and it would show that to the extent of at least 1000 or 2000 miles the use of galvanic electricity for the purposes of the electric telegraph was perfectly practicable. (pp. 53 to 55.)

TRIBOAILLET'S TELEGRAPH.

Mr. Triboaillet, in 1828, proposed the following arrangement for an electric telegraph:

A single wire only was to be used. The wire was to be covered with shell-lac, then wrapped with silk, and afterwards covered with resin. This insulated wire was then to be buried in the earth, inside glass tubes, the joints being carefully luted up and made water-tight. The electricity was to be generated by a powerful battery, and to act through the insulated wire on a delicate electroscope at the distant station.

Mr. Triboaillet prepared no particular form of code for his telegraph, but he left it to each telegraphist to form his own alphabet, on the principle of making the number of the motions to express the various letters or symbols desired to be denoted, as is now done with respect to the needle telegraph at present in use in England. (p. 55.)

SCHILLING'S TELEGRAPH.

M. Le Baron de Schilling appears to have invented two kinds of telegraph; one with five magnetic needles, and another with only one needle. The first had five needles, and was constructed at St. Petersburg in 1832.

By the single deflection of each of these five needles to the right or to the left, ten primary signals were obtained, and by means of a code or dictionary the combination of a few of such signals was made to express whole words or sentences. Schilling also invented an alarum. The motion of one of his magnetic needles allowed a weight to fall, and by the momentum, produced by such fall, to cause an alarum to sound.

Another of Schilling's plans, and of apparently later date, was to use only *one* magnetic needle, and by counting the

number of such motions of that needle to the right and left, to designate the letters of the alphabet thereby.

The telegraphs of Schilling were exhibited before the Emperor Alexander, as well as afterwards before the Emperor Nicholas, and were highly approved of by both. (p. 56.)

GAUSS AND WEBER'S TELEGRAPH.

In 1833 a telegraph was invented by Gauss and Weber at Gottingen. This consisted of a magnetic needle surrounded by a coil of wire, the needle being moved by the agency of electricity developed by the magneto-machine. The electricity generated was not sent simply in intermittent currents, but by means of mechanical contrivances, then well known, a constant current was produced so as to cause the deflection of the magnetic needle to continue for any desired period. The signals were to be made by the number of deflections to the right and left. When a total of five motions was made for each signal, the number of different signals transmitted would amount to more than all the letters of the alphabet, as well as all the numerals, and many spare signals for special objects would thus be produced.

This telegraph was constructed at Gottingen between the Observatory and the Cabinet de Physique (a distance of a mile and a quarter). The earth appears to have been used as part of the circuit. (p. 56.)

STEINHEIL'S TELEGRAPH.

This telegraph, in point of time, precedes the first patented telegraph in England. It was also a perfect arrangement. Dr. Steinheil could either telegraph by sound or by the making of permanent marks on paper; he employed both these different processes.

His telegraph consisted of *one* wire, and of one or two magnetic needles as desired. The needles, as in former plans, were surrounded by coils of wire, and each could be made to move to the right or left by electricity generated from the magneto-electric machine. When it was desired to telegraph by sound, he made the needles strike against either of two bells,—the one needle striking one bell, and the other needle striking another, differently toned. When he required to permanently record the intelligence, these needles were furnished with small tubes holding ink, and by their motions dots were made on paper properly moved in front of them by wound-up mechanism; one needle making dots in one line, and the other needle making dots in a line underneath the former.

Twelve miles of wire were erected, and intermediate as well as terminal stations employed. A portion of the wire was covered with zinc, and the ends of the wire at each distant terminus were joined to plates of metal buried in the earth, so that the earth formed one-half of the circuit.

He made his signals by a maximum of *four* dots. He used galvanized iron wire. He employed but one wire for his telegraph. He used the earth circuit; and he carried wire both under ground and in the air.

Steinheil's telegraph was in practical operation in July, 1837, was twelve miles long, and had three stations in the circuit.

During the year 1837 many telegraphs were invented. This is also the year in which the first patent was taken out for an electric telegraph in England. (pp. 57 to 59.)

MASSON'S TELEGRAPH.

At Caen, 1837, M. Masson erected a line of telegraph about a mile and a quarter long.

The power he employed was electricity, developed from the magneto-machine, which was made to operate on magnetic needles at the respective termini.

In 1838, M. Masson in conjunction with M. Breguet tried further experiments on a line of railway. (p. 60.)

PATENTED TELEGRAPHS.

COOKE AND WHEATSTONE'S TELEGRAPH.

On the 12th of June, 1837, Messrs. Cooke and Wheatstone took out letters patent in England for "improvements in giving signals and sounding alarums in distant places by means of electric currents transmitted through metallic circuits."

Many persons have long had an idea that Messrs. Cooke and Wheatstone were the first inventors of THE *electric telegraph*. It is clear, however, from what has been said before, and from the very title of this patent, which is for *improvements*,—and those improvements relating to certain particular parts only of the electric telegraph,—that such a notion is wholly erroneous.

The peculiar features of this telegraph were, as they are expressed in the title, *improvements* on the well known modes of making the signals and of sounding alarums.

Five magnetic needles and coils were used, and either five or six wires employed, accordingly as it was desired, by means of the needles, to produce twenty or thirty primary signals. The needles were arranged in a horizontal row and on a vertical dial, and stops were placed to cause each needle to remain inclined at a particular angle when acted on by electric currents.

Letters were engraved on the dial at the points where the lines of convergence of two needles met; by causing two of

the five needles to converge, a letter could be denoted. Five wires and five needles gave twenty of such signals; if a sixth wire were employed, but without a needle, then only *one* of the five needles could, if desired, be moved; and thus, by the single motion of each of the five needles to the right or left, ten other signals could be given.

The improvement relating to the alarum was the employment of the attractive force developed in soft iron (when electric currents were caused to pass round it in coils of wire) for the purpose of striking a bell or releasing wound-up mechanism.

It is clear that this telegraph, as a whole, was a great improvement on many others at that day, though still very far from perfect.

The peculiar arrangement of the dial at once reduced the number of wires which would have been required under Ampère's plan from twenty to five, although it must not be forgotten that *at this time many one-wired telegraphs were well known.*

A peculiar kind of key-board was employed, and other mechanical improvements effected. It must be observed, however, that this telegraph contains little or nothing new beyond *the peculiar combination* of well-known parts. The use of the needle and coil was old; the employment for telegraphic purposes of galvanic electricity was old; the burying of insulated wires in tubes was old; the attractive force of soft iron to develop electro-magnetic properties was old. But the peculiar mode of "*giving signals and sounding alarums*" (the words as given in the title) was new, and was an improvement on the then known plans of this class of telegraphs, and a *great improvement* too.

The author has been anxious to put this matter in what he considers its true light, as much misapprehension has

arisen as to what the real inventions in this patent were,—a misapprehension which he conceives has arisen from the great difficulty which all persons (excepting only those who have spent many years in this particular branch of science) experience in obtaining a correct knowledge as to what was and what was not the common stock of knowledge possessed by many parties at that date conversant with the science, and especially as to what had been already done in electric telegraphs.

To Professor Wheatstone himself credit must be given, not only of knowing what had been done in this country, but what had been proposed and done in almost every civilized country on the Continent, both as regards electricity and electric telegraphs; and hence the reason is obvious why the first patent taken out for an electric telegraph in this kingdom had in its title, for its security's sake, the word "IMPROVEMENTS."

The author conceives that great injury has been done to Professor Wheatstone and his partner Mr. Cooke by parties claiming for *them* the first invention of THE electric telegraph; whereas if those friends had but read the first published words of the inventors themselves, they would have found that all that they themselves had said was, that what they had invented were only certain *improvements*. Much undeserved bitterness and acrimony of feeling have thus been raised unjustly against the first *patentees* of improvements in electric telegraphs. (pp. 70–72.)

The principle of this invention is still in general use in England, but improvements have been made by which the number of needles has been reduced to two, and in some cases to one only. At first class offices two are used.

The average rate at which long messages were sent in 1849 by the needle telegraph, appears to have been about 17 words per minute. (p. 76.)

Mr. Highton describes a great number of telegraphs patented since 1838. He says that the simplest method of recording the communication on paper appears to be that of causing an electro-magnet to stamp or cut a piece of paper, and to make thereon long or short marks, accordingly as the current is continued for a long or short period.

He adds that the British Electric Telegraph Company intended for some kinds of intelligence, to use an arrangement by means of which a positive current of electricity will make one mark on paper, and a negative current a different and dissimilar mark according to the patented plans which they possess.

Some forms of the chemical telegraph, in which the electro-magnet is dispensed with, are very simple, and a slight electrical current is sufficient for working purposes, which is an important consideration.

MORSE'S TELEGRAPH.

This telegraph was patented in the U. S., 20 June, 1840.

" Professor Morse has stated that he invented his telegraph in 1832 : it does not appear however, that *any* telegraph was actually constructed, nor the thoughts of his brain *put in practice* until 1837. (p. 60.)*

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* What he proposed then, was for the most part abandoned afterwards, when he first attempted to transmit intelligence to a distance. Morse returned from Europe to the United States in March, 1839, and then gave up any attempt to bring a telegraph into use, and resumed his pencil in conjunction with the practice of the daguerreotype. Morse's deposition in the House case, (Record, p. 52.) A little over a year afterwards, however, he resolved to get a Patent, and on 20th June, 1840, he obtained the same, (a short time after a Patent had been issued to Cooke and Wheatstone.) But it was not until 1843–4, that Morse actually succeeded in constructing a telegraph. His first efforts in 1843 were failures, on account of defects in his apparatus. (See ante pp. 71 to 73.) Indeed he had proposed no practicable mode of transmitting electric currents to a distance, until 1843–4. (Ante, p. 73.)

Mr. Highton refers to Morse's letter to the Secretary of the Treasury of the United States, dated September 27, 1837, in which he states that he had not been able to test his plan until within a few weeks.

The peculiarities of Morse's telegraph, when made, were the use of one wire, and that wire either to be placed underground or in the air. A galvanic battery at the transmitting station was to furnish the power, and an electro-magnet of iron at the receiving station was to record the presence or passage of the power.

The armature of this electro-magnet was to have attached to it a pen with ink in, or a pencil, for the purpose of marking paper, which was to pass uniformly along in front of the pen. The pencil or pen was afterwards abandoned for the use of a steel pricker.

The first symbols used were characters like a V; afterwards, when the pricker was used, it made small holes in the paper, or formed long scratches on it, accordingly as the current of electricity was kept on for a short or long period. The combination of dots and long strokes thus formed his alphabet. This telegraph has been most extensively used in America, and is very simple both in construction and use.

The first experiment was made over half a mile, on the 2d October, 1837. (pp. 60 to 62.)*

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* Professor Hare, twenty-nine years Professor of Chemistry in the University of Pennsylvania, says in his deposition in the House case. (Record p. 96.)

"I consider that Professor Morse displayed great industry, zeal, sagacity and judgment in devising and carrying out his process, so far as it is original. But I do not conceive that, in consequence of any pretensions thus founded, the fruits of the labor of those who preceded him in the same path have become his property exclusively for the purpose of telegraphing. Had they not abandoned their discoveries to the public, they would have as good a right to them exclusively, as he has to his peculiar contrivances for rendering them available

INVENTION OF THE ELECTRIC TELEGRAPH NOW IN USE.

No *one* person can be strictly called the inventor of the electric telegraph.

In order to ascertain whether the honor of this magnificent invention can be ascribed to any *one single person*, let us *dissect* any of the forms of telegraph now in general use. Let us take, for example, the needle telegraph as now generally used by 'The Electric Telegraph Company' in England, and by its dissected parts show to whom is due the honor of the invention or discovery of each of its parts. (p. 137.)

Volta, in 1800, discovered the galvanic current.

Œrsted, in 1819, discovered that a magnetic needle was moved by the passage of an electric current through an adjoining wire.

Schwieger invented the coil.

Schilling, in 1832, placed the magnetic needles vertical.

Steinheil, in 1837, made the counting of the number of motions the basis of his alphabets.

Sturgeon discovered and invented the electro-magnet.

Schilling, in 1832, used a weight which was caused to fall by a current of electricity to sound a bell.

Wheatstone and Cooke, in 1845, made a similar falling weight to liberate wound-up mechanism, and thus to sound a bell.

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in the transmission of intelligence. But as they did abandon their discoveries to the public, the public are now vested with the right thus abandoned, and while permitting to Professor Morse all that is new and peculiar in his apparatus, ought to extend the same privilege to others who may devise apparatus distinct from his.

"Professor Morse had pecuniary assistance from the government in putting his telegraphic apparatus into operation. This was an advantage not accorded to his competitors. Independently of that assistance, he would not, probably, have had the claim to priority on which he insists."

Early experimenters showed that glass, porcelain, and resin were insulators of electricity.

Watson, in 1747, sent currents of electricity through wires suspended in the air on posts.

Steinheil, in 1837, used wires suspended in the air, and buried in the ground, for an electric telegraph.

Cooke, in 1842, patented a *particular method* of suspending wires in the air, and a particular *form* of glass and porcelain for insulators.

Watson, in 1747, showed that one half of an electric current might be formed of the earth.

Steinheil, in 1837, used the same for telegraphic purposes, as did also Cooke and Wheatstone in 1842.

No one can then say that any *one* person is the inventor of the electric telegraph, as now generally in use in England; in which galvanic batteries,—coils of wire,—moveable magnets —electro-magnets,—wires on posts in the air,—wires under ground,—earth plates,—and the counting of the signals to compose the alphabet, form the entire telegraph.

Each one of the above-named persons has a right to claim the discovery or invention of *one* of those parts, and numerous others have an equal right to claim the invention of many of the *combinations* contained in such telegraph.

The same may be said of every telegraph now in use throughout the world.

The *complete telegraph* is a joint invention. Each person has employed in building up his particular telegraph the discoveries and inventions of many others.

Too great praise, however, cannot be bestowed on Mr. W. F. Cooke, for his unwearied and energetic exertions in putting into practical operation the inventions of Professor Wheatstone and himself.

It is owing to these exertions on the part of Mr. Cooke

that this kingdom can now boast of having received the benefits of telegraphic communication as early as any other country. (pp. 137, 138.)

The great *distinguishing feature* of the *majority* of the telegraphs at present used in Great Britain is, that they are of the class known as oscillating telegraphs, *i.e.* telegraphs in which the letters are denoted by the number of motions to the right or left of a needle or an indicator.

The wires in England have hitherto been almost universally erected on posts. The insulation however is at present by no means perfect. (p. 142.)

TELEGRAPHS IN AMERICA.

In America three kinds of telegraph are in use, viz. Morse's, Bain's, and House's. Morse's telegraph, which has already been described, is at present the most generally employed. Bain's chemically marking telegraph comes next; and, lastly, Professor's House's, which is on the step-by-step movement principle, and which prints in ordinary letters the intelligence transmitted. This telegraph is at present used only to a very limited extent in the United States, and is known in England as the telegraph of Mr. Jacob Brett. (p. 143.)*

* Mr. Jacob Brett took out a patent in England as assignee of Mr. House. The patent was taken in the name of Mr. Brett, as for an imported invention. Mr. Brett has since introduced some alterations in the original form of the printing telegraph, but has not yet had the recent improvements made by Mr. House. and patented, by him on the 28th December, 1852, by which great rapidity is attained, and a variety of defects in detail removed. Since these improvements were effected House's Printing Telegraph has been rapidly extended in the United States. (See ante page 20.) Mr. Brett is the patentee of one of the Submarine Telegraphs which has recently been laid across the English channel to France, Belgium, and in various other parts of Europe.

Mr. Highton describes the telegraphs now used in different parts of Europe, and mentions that in England the double needle telegraph is most used; whilst in France, Prussia, and Germany, the class known as revolving pointer telegraphs is preferred. He concludes (p. 178) with the following remarks:—

"It must not be forgotten that the electric telegraph is now only in its infancy. Much has yet to be accomplished, and wonderful discoveries still await the patient and laborious student.

Who could have thought that the accidental contraction of the muscles of a frog would have paved the way to such brilliant results as have already appeared!

The falling apple led to the discovery of the power of gravity, and what may not a further search into the hidden mystery of electricity ultimately bring to light!

Electricity and steam have now become the great civilizers of mankind. Time and space are all but annihilated. Years are converted into days, days into seconds, and miles have become mere fractions of an inch.

No fairy dream could ever surpass the wonders of the present age. The ray of light is caused—*itself* to paint the verdant landscape, or trace the features of our dearest friends. The power of heat is made to carry us whithersoever we will—it transports alike the luscious fruits of the tropics to the colder regions of the earth, or carries the cooling ice to assuage the parching thirst of sunny climes, and last, but not least, that tiny thread of wire which dangles in the air conveys a silent current far away, and thus transacts the business of a mighty trade and commerce, and carries our very thoughts to dear and distant friends. All this is the work of the last half century. Who can tell what another century may bring forth!

Search further, ye patient laborers in the field of electricity, for many brilliant discoveries await you still. Examine well the laws that govern this subtle power, and soon will you meet your reward. The field is rieh in the extreme. Careful study, and direct experiments, are alone required to add fresh laurels to the many that already adorn the brows of the philosophers of the present age."

CONTENTS.

House's Printing Telegraph.

Extracts from Dr. Turnbull's Lectures on the Electro-Magnetic Telegraph.

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J W J Clarke